

City of Houston



Northeast Water Purification Plant

Electrical Power System Studies

March 2014



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Section 1

Executive Summary

1.1 Purpose of Electrical Studies

There is a future project to add adjustable speed drives (ASDs) on three high service pumps at the Northeast Water Purification Plant (NEWPP). The studies in this report have been performed to determine the impact of the High Service Pump Station (HSPS1) ASD additions. This report includes Electrical Short Circuit and Protective Device Coordination Studies. These studies have developed available short circuit currents which will be used to determine equipment ratings during the future design of the HSPS1 ASD project. The studies also include recommended settings for protective relays and circuit breakers associated with the HSPS1 ASD project.

1.2 Scope of Electrical Studies

Electrical Power System Studies start at the 138 kV bus supplied by CenterPoint Energy (CNP). The studies include the 138-12.47 kV substation, 12.47 kV feeder circuits, 12.47-4.16 kV substations, 4.16 kV switchgear, 12.47 kV- 480 volt substations and 480 volt switchgear.

Every effort has been made to achieve maximum coordination between devices on the same feeder circuit. Where coordination cannot be achieved for all devices, some devices may be intentionally allowed to have overlapping coordination and these devices may trip for the same current and time.

1.3 Description of Electrical Studies

1.3.1 Electrical System Computer Model

The first activity in performing electrical studies is to gather data so a computer model (data base) can be developed for the electrical system. Each of the studies in this report used the common data base. This data includes information from plant record drawings, conductor lengths determined as part of the data base development, equipment data and information from the electric utility company (CenterPoint Energy). SKM System Analysis, Inc. software was used for the data base and electrical studies.

1.3.2 Short Circuit Study

A Short Circuit Study has been performed using the data base and SKM software to determine the current available at each equipment location at the facility if one or more of the three phases of the electrical system short to another phase or ground. Typically, the worst-case scenario is when all three phases short together. When one or more phases of an electrical system experience a short circuit event, very high current (many times normal levels) flows through electrical components. In order for personnel to be safe and plant equipment not to be damaged, electrical equipment must withstand the high current that

exists during short circuit events. The results of the Short Circuit Study are used to determine short circuit ratings for equipment and to determine cutoff limits for protective devices in the Coordination Study.

1.3.4 Coordination Study

As electric power flows from the point of service with an electric utility company to end-use equipment, power flows through many protective devices (fuses and circuit breakers). If an electrical short circuit develops with a piece of end-use equipment, it is desirable that only the circuit breaker or fuse immediately upstream (toward the point of service) of the short circuit should operate (fuse blows or circuit breaker trips) to stop the flow of short circuit current. When only the fuse or circuit breaker immediately upstream of the short circuit operates for a short circuit event, the upstream fuses and circuit breakers are coordinated with the fuse or circuit breaker, which operated. A coordinated electrical system is one, which is able to selectively isolate a short circuit and leave the remainder of the electrical system minimally affected and continuing to operate.

In order to coordinate an electrical system, time versus current curves are plotted for each protective device. Examples of time-current curves are included in Section 5 of this report. Curves must be selected so that curves do not cross and there is sufficient clearance between curves for fuse or circuit breaker operating times. Not every fuse or circuit breaker in a system can be coordinated with upstream protective devices. This means for a particular short circuit event, more of the facility may be affected than if the facility was completely coordinated, due to limitations of the electrical equipment and components involved.

1.3.5 Protective Device Settings

Some protective devices, such as fuses or fixed trip circuit breakers do not have settings. Fuses are purchased based on type of fuse and ampacities, and installed without adjustment. Other protective devices, such as protective relays and adjustable trip circuit breakers can have numerous adjustments.

1.4 Basis of Electrical Study

The data for this study was collected from various sources which included:

- a. Existing plant Record Drawings from Construction Phases 1 and 2.
- b. Existing 138 kV Substation Phase 1 Record Drawings by Dashiell Corporation.
- c. Vendor drawings and data sheets.
- d. A previous power system study by EPE in July of 2003.
- e. A previous power system study by MAS Engineering/Kalluri Group dated 7-16-2012.
- f. Square D Services June, 2010 field test reports.
- g. Field data collected by Kalluri Group.
- h. Field verification of CT ratios by Kalluri Group.
- i. Existing protective relay settings by Saber Power.

1.5 NRG Generator Connection

NRG has 10 – 500 kW diesel engine standby generators at the NEWPP which can be paralleled and used to provide power if service from CenterPoint Energy is not available. In order for the NEWPP to use NRG standby generator power, City personnel must manually open 12.47 kV circuit breakers “MA” and “MB” and close the tie circuit breaker in Switchgear “SWGR-S”. This arrangement prevents the NRG generators from paralleling with CenterPoint Energy. The available short circuit current from CenterPoint Energy is much greater than that available from the NRG generators so the NRG generators have no impact on the studies in this report.

1.6 Report Comments

- a. The size of the current transformer (CT) in the neutral grounding resistor of unit substation Transformers T8A and T8B is uncertain. Record drawings do not indicate neutral grounding resistor CT size. The EPE July 2003 Power System Study indicated a CT size of 400/5. Due to the neutral grounding resistor location on top of the unit substation transformers it is difficult to access the neutral grounding resistor CTs. When Transformers T8A and T8B are relocated for service to a new electrical building for new ASDs, the existing CTs can be replaced with 400/5 CTs. A CT ratio of 400/5 has been used for the neutral grounding resistor for T8A and T8B in this report.
- b. Record drawings and field observations indicate ANSI Devices 67 and 67N (directional overcurrent relays) are included on the 12.47 kV Main Circuit Breakers in Switchgear “SWGR-S”. It is our understanding that when operating on power from CenterPoint Energy, it is the City’s operating philosophy to never close the 12.47 kV tie circuit breaker unless Main Circuit Breaker “MA” or “MB” is open. We also understand there is interlock wiring to prevent “MA”, “MB” and the 12.47 kV tie circuit breaker from being closed at the same time. We have not observed testing to prove interlock wiring is functional. Based on the above described operating philosophy, Devices 67 and 67N are not needed to detect power flow from the NEWPP to CenterPoint Energy. At the City’s option, Devices 67 and 67N can be left in service in the event the City changes operating philosophy.

1.7 Recommendations

- a. The addition of ASDs on three high service pumps will change the configuration of the power system to the High Service Pump Station. The new configuration will add protective relays and will require new settings for some existing relays and circuit breakers. Setting for relays and circuit breakers are located in Section 5 of this report.

Section 2

System Input Data

2.1 Short Circuit Current Available from CenterPoint Energy (CNP)

The Thevenin Equivalent System Impedance for the 138 kV Deusen Substation (this is the substation which powers the NEWPP) with both 138 kV lines in service is:

$$Z_+ = 0.02650 \text{ pu, } X/R = 9.79$$

$$Z_- = 0.02648 \text{ pu, } X/R = 9.73$$

$$Z_0 = 0.07238 \text{ pu, } X/R = 5.45$$

The above values are based on 100 MVA_b, 138 kV_b and a Thevenin equivalent voltage of 1.0285 pu. The three phase short circuit current is 3992 MVA and the single phase short circuit current is 2516 MVA.

The above information is from a CNP memo by Mr. William Allen dated 9-16-2011 which can be found in Section 8, Appendix.

2.2 Input Data Description

The SKM One-Line Diagram included in this section of the report summarizes major electrical equipment which is included in the computer model. A copy of the computer model input data is also included in this report section. Summarized below is a brief explanation of the type of input data used to develop the computer model.

- Contribution Data includes Utility and Motor data. Utility contribution data lists the available short circuit current at the secondary of each utility power transformer. Motor Contribution Data lists the short circuit reactance of rotating machines and the per-unit impedance of rotating machines on a 100 MVA base.
- Feeder Input Data lists cable impedance in ohms per 1,000 feet (Ohms / M Length), and per-unit impedance on a 100 MVA base.
- Transformer Input Data lists transformer data in per-unit impedance on a 100 MVA

2.3 Input Data

Input Data follows this page.

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY
SKM DISCLAIMS ANY RESPONSIBILITY AND LIABILITY RESULTING
FROM THE USE AND INTERPRETATION OF THIS SOFTWARE.

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INPUT DATA REPORT
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ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE.

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
BD 1	TR1 SEC	12.47kV BUS-A	1	12470	50.0 FEET	1200	Copper	
	Duct Material:	Bus		Insulation Type:	****		Insulation Class:	
	+/- Impedance:	0.0119 + J 0.0619		Ohms/1000 ft		0.00038 + J	0.0020 PU	
	Z0 Impedance:	0.0710 + J 0.3314		Ohms/1000 ft		0.0023 + J	0.0107 PU	
BD 2	TR2 SEC	12.47kV BUS-B	1	12470	50.0 FEET	1200	Copper	
	Duct Material:	Bus		Insulation Type:	****		Insulation Class:	
	+/- Impedance:	0.0119 + J 0.0619		Ohms/1000 ft		0.00038 + J	0.0020 PU	
	Z0 Impedance:	0.0710 + J 0.3314		Ohms/1000 ft		0.0023 + J	0.0107 PU	
CBL 6-B1	SWBD-6B	MCC-1B	2	480	640.0 FEET	500	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:			Insulation Class:	THHN
	+/- Impedance:	0.0276 + J 0.0373		Ohms/1000 ft		3.83 + J	5.18 PU	
	Z0 Impedance:	0.0438 + J 0.0999		Ohms/1000 ft		6.08 + J	13.88 PU	
CBL MCC1A	SWBD-6A	MCC-1A	2	480	640.0 FEET	500	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:			Insulation Class:	THHN
	+/- Impedance:	0.0276 + J 0.0373		Ohms/1000 ft		3.83 + J	5.18 PU	
	Z0 Impedance:	0.0438 + J 0.0999		Ohms/1000 ft		6.08 + J	13.88 PU	
CBL-0074	SWBD 7A	MCC3A	2	480	50.0 FEET	350	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:		PVC	Insulation Class:	THWN
	+/- Impedance:	0.0368 + J 0.0393		Ohms/1000 ft		0.3993 + J	0.4264 PU	
	Z0 Impedance:	0.0585 + J 0.0999		Ohms/1000 ft		0.6348 + J	1.08 PU	
CBL-0075	SWBD 7B	MCC3B	2	480	50.0 FEET	350	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:		PVC	Insulation Class:	THWN
	+/- Impedance:	0.0368 + J 0.0393		Ohms/1000 ft		0.3993 + J	0.4264 PU	
	Z0 Impedance:	0.0585 + J 0.0999		Ohms/1000 ft		0.6348 + J	1.08 PU	
CBL-0085	SWBD-6A	MCC-2C	1	480	50.0 FEET	500	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:		PVC	Insulation Class:	THWN
	+/- Impedance:	0.0276 + J 0.0373		Ohms/1000 ft		0.5990 + J	0.8095 PU	
	Z0 Impedance:	0.0438 + J 0.0999		Ohms/1000 ft		0.9505 + J	2.17 PU	
CBL-0086	SWBD-6B	MCC-2D	1	480	50.0 FEET	500	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:		PVC	Insulation Class:	THWN
	+/- Impedance:	0.0276 + J 0.0373		Ohms/1000 ft		0.5990 + J	0.8095 PU	
	Z0 Impedance:	0.0438 + J 0.0999		Ohms/1000 ft		0.9505 + J	2.17 PU	
CBL-02P01-1	SWBD-5A	02P01 VFD	2	480	60.0 FEET	500	Copper	
	Duct Material:	Non-Magnetic		Insulation Type:			Insulation Class:	THHN
	+/- Impedance:	0.0276 + J 0.0373		Ohms/1000 ft		0.3594 + J	0.4857 PU	
	Z0 Impedance:	0.0438 + J 0.0999		Ohms/1000 ft		0.5703 + J	1.30 PU	

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-02P01-2	BUS-0095	02-P-01 TERM	2	480	60.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.3594 + J 0.4857		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.5703 + J 1.30		PU	
CBL-02P02-1	SWBD 5B	02P02 VFD	2	480	60.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.3594 + J 0.4857		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.5703 + J 1.30		PU	
CBL-02P02-2	BUS-0096	02-P-02 TERM	1	480	60.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.1010 + J 0.0426		Ohms/1000 ft		2.63 + J 1.11		PU	
	Z0 Impedance: 0.1605 + J 0.1083		Ohms/1000 ft		4.18 + J 2.82		PU	
CBL-02P03-1	SWBD-5A	02P03 RVSSS	2	480	40.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.2396 + J 0.3238		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.3802 + J 0.8672		PU	
CBL-02P03-2	02P03 RVSSS	02-P-03 TERM	2	480	70.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.4193 + J 0.5666		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.6654 + J 1.52		PU	
CBL-02P04-1	SWBD 5B	02P04 RVSSS	2	480	40.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.2396 + J 0.3238		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.3802 + J 0.8672		PU	
CBL-02P04-2	02P04 RVSSS	02-P-03 TERM0	2	480	70.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.4193 + J 0.5666		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.6654 + J 1.52		PU	
CBL-02P05-1	SWBD-5A	02P05 RVSSS	2	480	40.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.2396 + J 0.3238		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.3802 + J 0.8672		PU	
CBL-02P05-2	02P05 RVSSS	02-P-05 TERM	2	480	70.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.4193 + J 0.5666		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.6654 + J 1.52		PU	

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-04ME01-1	SWBD-6A	04ME01 RVSSS	1	480	40.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft		1.10 + J	0.6910	PU	
	ZO Impedance: 0.1006 + J 0.1012		Ohms/1000 ft		1.75 + J	1.76	PU	
CBL-04ME01-2	04ME01 RVSSS	04-ME-01 TERM	1	480	320.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft		8.79 + J	5.53	PU	
	ZO Impedance: 0.1006 + J 0.1012		Ohms/1000 ft		13.97 + J	14.06	PU	
CBL-04ME02-1	SWBD-6B	04ME02 RVSSS	1	480	40.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft		1.10 + J	0.6910	PU	
	ZO Impedance: 0.1006 + J 0.1012		Ohms/1000 ft		1.75 + J	1.76	PU	
CBL-04ME02-2	04ME02 RVSSS	04-ME-02 TERM	1	480	320.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft		8.79 + J	5.53	PU	
	ZO Impedance: 0.1006 + J 0.1012		Ohms/1000 ft		13.97 + J	14.06	PU	
CBL-05P01-1	SWBD-6A	05P01 VFD	2	480	50.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		0.3993 + J	0.4264	PU	
	ZO Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		0.6348 + J	1.08	PU	
CBL-05P01-2	BUS-0087	05-P-01 TERM	2	480	200.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		1.60 + J	1.71	PU	
	ZO Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		2.54 + J	4.34	PU	
CBL-05P02-1	SWBD-6B	05P02 VFD	2	480	50.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		0.3993 + J	0.4264	PU	
	ZO Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		0.6348 + J	1.08	PU	
CBL-05P02-2	BUS-0091	05-P-02 TERM	2	480	200.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		1.60 + J	1.71	PU	
	ZO Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		2.54 + J	4.34	PU	
CBL-05P03-1	SWBD-6A	05P03 RVSSS	2	480	40.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		0.3194 + J	0.3411	PU	
	ZO Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		0.5078 + J	0.8672	PU	

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-05P03-2	05P03 RVSSS	05-P-03 TERM	2	480	200.0 FEET	350	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	THHN
	+/- Impedance: 0.0368 + J 0.0393		Ohms/1000 ft		1.60 + J 1.71		PU	
	Z0 Impedance: 0.0585 + J 0.0999		Ohms/1000 ft		2.54 + J 4.34		PU	
CBL-08-P-1-1	HSPS1-BUSB	BUS-0114	1	4160	80.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.0472 + J 0.0233		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.0749 + J 0.0593		PU	
CBL-08-P-1-2	BUS-0115	08-P-01 TERM	1	4160	325.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.1916 + J 0.0947		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.3044 + J 0.2408		PU	
CBL-08-P-2-1	HSPS1-BUSB	BUS-0112	1	4160	95.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.0560 + J 0.0277		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.0890 + J 0.0704		PU	
CBL-08-P-2-2	BUS-0113	08-P-03 TERM	1	4160	310.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.1827 + J 0.0903		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.2904 + J 0.2296		PU	
CBL-08-P-3	HSPS1-BUSB	08-P-02 TERM	1	4160	395.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.2328 + J 0.1150		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.3700 + J 0.2926		PU	
CBL-08-P-4	HSPS1-BUSB	08-P-04 TERM	1	4160	405.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.2387 + J 0.1180		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.3794 + J 0.3000		PU	
CBL-08-P-6	HSPS1-BUSA	08-P-05 TERM	1	4160	390.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.2299 + J 0.1136		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.3653 + J 0.2889		PU	
CBL-08-P-7	HSPS1-BUSA	08-P-07 TERM	1	4160	400.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR		Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.2358 + J 0.1165		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.3747 + J 0.2963		PU	

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-08-P-8-1	HSPS1-BUSA	BUS-0134	1	4160	60.0	FEET	2/0	Copper
	Duct Material: Non-Magnetic		Insulation Type:			EPR	Insulation Class:	
	+/- Impedance: 0.1020 + J		0.0504	Ohms/1000 ft		0.0354 + J	0.0175 PU	
	Z0 Impedance: 0.1621 + J		0.1282	Ohms/1000 ft		0.0562 + J	0.0444 PU	
CBL-08-P-8-2	BUS-0110	08-P-8-TERM	1	4160	345.0	FEET	2/0	Copper
	Duct Material: Non-Magnetic		Insulation Type:			EPR	Insulation Class:	
	+/- Impedance: 0.1020 + J		0.0504	Ohms/1000 ft		0.2033 + J	0.1005 PU	
	Z0 Impedance: 0.1621 + J		0.1282	Ohms/1000 ft		0.3232 + J	0.2556 PU	
CBL-MCC2A	SWBD-6A	MCC-2A	2	480	60.0	FEET	350	Copper
	Duct Material: Non-Magnetic		Insulation Type:				Insulation Class:	
	+/- Impedance: 0.0368 + J		0.0393	Ohms/1000 ft		0.4792 + J	0.5117 PU	
	Z0 Impedance: 0.0585 + J		0.0999	Ohms/1000 ft		0.7617 + J	1.30 PU	
CBL-MCC2B	SWBD-6B	MCC-2B	2	480	50.0	FEET	500	Copper
	Duct Material: Non-Magnetic		Insulation Type:				Insulation Class:	
	+/- Impedance: 0.0276 + J		0.0373	Ohms/1000 ft		0.2995 + J	0.4047 PU	
	Z0 Impedance: 0.0438 + J		0.0999	Ohms/1000 ft		0.4753 + J	1.08 PU	
CBL-STDBYSWBD	SWBD-6A	SWBD STDBY	2	480	40.0	FEET	350	Copper
	Duct Material: Non-Magnetic		Insulation Type:				Insulation Class:	
	+/- Impedance: 0.0368 + J		0.0393	Ohms/1000 ft		0.3194 + J	0.3411 PU	
	Z0 Impedance: 0.0585 + J		0.0999	Ohms/1000 ft		0.5078 + J	0.8672 PU	
CBL-SWBD11A	SWBD-6A	SWBD-11A	2	480	735.0	FEET	250	Copper
	Duct Material: Non-Magnetic		Insulation Type:				Insulation Class:	
	+/- Impedance: 0.0541 + J		0.0396	Ohms/1000 ft		8.63 + J	6.32 PU	
	Z0 Impedance: 0.0860 + J		0.1007	Ohms/1000 ft		13.72 + J	16.06 PU	
CBL-SWBD11B	SWBD-6B	SWBD-11B	2	480	735.0	FEET	250	Copper
	Duct Material: Non-Magnetic		Insulation Type:				Insulation Class:	
	+/- Impedance: 0.0541 + J		0.0396	Ohms/1000 ft		8.63 + J	6.32 PU	
	Z0 Impedance: 0.0860 + J		0.1007	Ohms/1000 ft		13.72 + J	16.06 PU	
CBL-T2A PRI 1	12.47kV BUS-A	T2A POLE 1	1	12470	750.0	FEET	2/0	Copper
	Duct Material: Non-Magnetic		Insulation Type:			XLP	Insulation Class:	
	+/- Impedance: 0.1020 + J		0.0504	Ohms/1000 ft		0.0492 + J	0.0243 PU	
	Z0 Impedance: 0.1621 + J		0.1282	Ohms/1000 ft		0.0782 + J	0.0618 PU	
CBL-T2A PRI 2	T2A POLE 2	BUS-0123	1	12470	50.0	FEET	2/0	Copper
	Duct Material: Non-Magnetic		Insulation Type:			XLP	Insulation Class:	
	+/- Impedance: 0.1020 + J		0.0504	Ohms/1000 ft		0.0033 + J	0.0016 PU	
	Z0 Impedance: 0.1621 + J		0.1282	Ohms/1000 ft		0.0052 + J	0.0041 PU	

THHN

THHN

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THHN

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-T2A SEC	T2A SEC	SWBD-5A	8	480	40.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.0599 + J 0.0809		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.0951 + J 0.2168		PU	
CBL-T2B PRI 1	12.47kV BUS-B	T2B POLE 1	1	12470	800.0 FEET	1/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		XLP Insulation Class:			
	+/- Impedance: 0.1280 + J 0.0507		Ohms/1000 ft		0.0659 + J 0.0261		PU	
	Z0 Impedance: 0.2034 + J 0.1289		Ohms/1000 ft		0.1046 + J 0.0663		PU	
CBL-T2B PRI 2	T2B POLE 2	BUS-0124	1	12470	50.0 FEET	1/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		XLP Insulation Class:			
	+/- Impedance: 0.1280 + J 0.0507		Ohms/1000 ft		0.0041 + J 0.0016		PU	
	Z0 Impedance: 0.2034 + J 0.1289		Ohms/1000 ft		0.0065 + J 0.0041		PU	
CBL-T2B SEC	T2B SEC	SWBD 5B	8	480	40.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.0599 + J 0.0809		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.0951 + J 0.2168		PU	
CBL-T6A PRI	12.47kV BUS-A	BUS-0125	1	12470	230.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		XLP Insulation Class:			
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.0151 + J 0.0075		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.0240 + J 0.0190		PU	
CBL-T6A SEC	T6A SEC	SWBD-6A	8	480	50.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.0749 + J 0.1012		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.1188 + J 0.2710		PU	
CBL-T6B PRI	12.47kV BUS-B	BUS-0126	1	12470	290.0 FEET	1/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		XLP Insulation Class:			
	+/- Impedance: 0.1280 + J 0.0507		Ohms/1000 ft		0.0239 + J 0.0095		PU	
	Z0 Impedance: 0.2034 + J 0.1289		Ohms/1000 ft		0.0379 + J 0.0240		PU	
CBL-T6B SEC	T6B SEC	SWBD-6B	8	480	50.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		Insulation Class:		THHN	
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft		0.0749 + J 0.1012		PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft		0.1188 + J 0.2710		PU	
CBL-T7A PRI	12.47kV BUS-A	BUS-0127	1	12470	910.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		XLP Insulation Class:			
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft		0.0597 + J 0.0295		PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft		0.0949 + J 0.0750		PU	

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-T7A SEC	BUS-0080	SWBD 7A	8	480	50.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			PVC	Insulation Class:	THWN
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft			0.0749 + J 0.1012	PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft			0.1188 + J 0.2710	PU	
CBL-T7B PRI	12.47kV BUS-B	BUS-0129	1	12470	910.0 FEET	2/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			XLP	Insulation Class:	
	+/- Impedance: 0.1020 + J 0.0504		Ohms/1000 ft			0.0597 + J 0.0295	PU	
	Z0 Impedance: 0.1621 + J 0.1282		Ohms/1000 ft			0.0949 + J 0.0750	PU	
CBL-T7B SEC	BUS-0078	SWBD 7B	8	480	50.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			PVC	Insulation Class:	THWN
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft			0.0749 + J 0.1012	PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft			0.1188 + J 0.2710	PU	
CBL-T8A PRI	12.47kV BUS-A	BUS-0130	2	12470	520.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			XLP	Insulation Class:	
	+/- Impedance: 0.0284 + J 0.0421		Ohms/1000 ft			0.0047 + J 0.0070	PU	
	Z0 Impedance: 0.0451 + J 0.1071		Ohms/1000 ft			0.0075 + J 0.0179	PU	
CBL-T8A SEC	T8A SEC	HSPS1-BUSA	6	4160	100.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			EPR	Insulation Class:	MV
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft			0.0027 + J 0.0036	PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft			0.0042 + J 0.0096	PU	
CBL-T8B PRI	12.47kV BUS-B	BUS-0131	2	12470	505.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			XLP	Insulation Class:	
	+/- Impedance: 0.0284 + J 0.0421		Ohms/1000 ft			0.0046 + J 0.0068	PU	
	Z0 Impedance: 0.0451 + J 0.1071		Ohms/1000 ft			0.0073 + J 0.0174	PU	
CBL-T8B SEC	T8B SEC	HSPS1-BUSB	6	4160	60.0 FEET	500	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			EPR	Insulation Class:	MV
	+/- Impedance: 0.0276 + J 0.0373		Ohms/1000 ft			0.0016 + J 0.0022	PU	
	Z0 Impedance: 0.0438 + J 0.0999		Ohms/1000 ft			0.0025 + J 0.0058	PU	
CBL-TA	HSPS1-BUSA	BUS-0116	1	4160	20.0 FEET	2	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			EPR	Insulation Class:	
	+/- Impedance: 0.2020 + J 0.0547		Ohms/1000 ft			0.0233 + J 0.0063	PU	
	Z0 Impedance: 0.3211 + J 0.1391		Ohms/1000 ft			0.0371 + J 0.0161	PU	
CBL-TA SEC	BUS-0121	HA	1	480	40.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:			PVC	Insulation Class:	THWN
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft			1.10 + J 0.6910	PU	
	Z0 Impedance: 0.1006 + J 0.1012		Ohms/1000 ft			1.75 + J 1.76	PU	

Northeast Water Purification Plant

All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE	
CBL-TB PRI	HSPS1-BUSB	BUS-0117	1	4160	20.0 FEET	2	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		EPR	Insulation Class:		
	+/- Impedance: 0.2020 + J 0.0547		Ohms/1000 ft		0.0233 + J	0.0063 PU		
	Z0 Impedance: 0.3211 + J 0.1391		Ohms/1000 ft		0.0371 + J	0.0161 PU		
CBL-TB SEC	BUS-0120	HB	1	480	40.0 FEET	4/0	Copper	
	Duct Material: Non-Magnetic		Insulation Type:		PVC	Insulation Class: THWN		
	+/- Impedance: 0.0633 + J 0.0398		Ohms/1000 ft		1.10 + J	0.6910 PU		
	Z0 Impedance: 0.1006 + J 0.1012		Ohms/1000 ft		1.75 + J	1.76 PU		

Northeast Water Purification Plant

All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

TRANSMISSION LINE

TRANSMISSION LINE NAME	FROM BUS NAME	TO BUS NAME	QTY VOLTS /PH L-L	LENGTH
XLN-T2A	T2A POLE 1	T2A POLE 2	1 12470.00	1.84 Miles
	+ Seq Impedance: 0.331131 + J 0.664506 Per Unit; Equi. Shunt B: 1.10548e-005			
	0 Seq Impedance: 1.14791 + J 2.82825 Per Unit; Equi. Shunt B: 4.00976e-006			
	% SERIES COMP: 0 From Shunt(MVA): 0.0000 To Shunt(MVA): 0.0000			
XLN-T2B	T2B POLE 1	T2B POLE 2	1 12470.00	1.84 Miles
	+ Seq Impedance: 0.331131 + J 0.664506 Per Unit; Equi. Shunt B: 1.10548e-005			
	0 Seq Impedance: 1.14791 + J 2.82825 Per Unit; Equi. Shunt B: 4.00976e-006			
	% SERIES COMP: 0 From Shunt(MVA): 0.0000 To Shunt(MVA): 0.0000			

Northeast Water Purification Plant

All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

EQUIVALENT PI DATA

PI NAME	FROM NAME	TO NAME	VOLTS
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TRANSFORMER INPUT DATA

TRANSFORMER NAME	PRIMARY RECORD NO	RECORD NAME	VOLTS L-L	* SECONDARY RECORD NO	RECORD NAME	VOLTS L-L	FULL-LOAD KVA	NOMINAL KVA
T1	CNP 138 kV	D	138000.	TR1 SEC	YG	12470.0	20000.0	12000.0
	Pos. Seq. Z%:		0.528 + J	8.98	(Zpu 0.044 + j	0.748)		Shell Type
	Zero Seq. Z%:		0.407 + J	6.93	(Sec 34.76 + j	0.577 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.
	Secondary Neutral Z:		18.00 + J		0.000 Ohms			
T2	CNP 138 kV	D	138000.	TR2 SEC	YG	12470.0	20000.0	12000.0
	Pos. Seq. Z%:		0.528 + J	8.98	(Zpu 0.044 + j	0.748)		Shell Type
	Zero Seq. Z%:		0.407 + J	6.93	(Sec 34.76 + j	0.577 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.
	Secondary Neutral Z:		18.00 + J		0.000 Ohms			
T2A	BUS-0123	D	12470.0	T2A SEC	YG	480.00	2576.00	2000.00
	Pos. Seq. Z%:		0.788 + J	5.75	(Zpu 0.394 + j	2.87)		Shell Type
	Zero Seq. Z%:		0.788 + J	5.75	(Sec 0.394 + j	2.87 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.
T2B	BUS-0124	D	12470.0	T2B SEC	YG	480.00	2576.00	2000.00
	Pos. Seq. Z%:		0.788 + J	5.75	(Zpu 0.394 + j	2.87)		Shell Type
	Zero Seq. Z%:		0.788 + J	5.75	(Sec 0.394 + j	2.87 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.
T6A	BUS-0125	D	12470.0	T6A SEC	YG	480.00	2576.00	2000.00
	Pos. Seq. Z%:		0.801 + J	5.85	(Zpu 0.400 + j	2.92)		Shell Type
	Zero Seq. Z%:		0.801 + J	5.85	(Sec 0.400 + j	2.92 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.
T6B	BUS-0126	D	12470.0	T6B SEC	YG	480.00	2576.00	2000.00
	Pos. Seq. Z%:		0.788 + J	5.75	(Zpu 0.394 + j	2.87)		Shell Type
	Zero Seq. Z%:		0.788 + J	5.75	(Sec 0.394 + j	2.87 Pri		Open)
	Taps Pri. 0.000 %		Sec. 0.000 %		Phase Shift (Pri. Leading Sec.):			30.00 Deg.

Northeast Water Purification Plant

All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

TRANSFORMER INPUT DATA

TRANSFORMER NAME	PRIMARY RECORD NO NAME	VOLTS L-L	* SECONDARY RECORD NO NAME	VOLTS L-L	FULL-LOAD KVA	NOMINAL KVA
T7A	BUS-0127	D 12470.0	BUS-0080	YG 480.00	2000.00	2000.00
	Pos. Seq. Z%:	0.761 + J 5.55	(Zpu 0.380 + j 2.77)			Shell Type
	Zero Seq. Z%:	0.761 + J 5.55	(Sec 0.380 + j 2.77 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.
T7B	BUS-0129	D 12470.0	BUS-0078	YG 480.00	2000.00	2000.00
	Pos. Seq. Z%:	0.774 + J 5.65	(Zpu 0.387 + j 2.82)			Shell Type
	Zero Seq. Z%:	0.774 + J 5.65	(Sec 0.387 + j 2.82 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.
T8A	BUS-0130	D 12470.0	T8A SEC	YG 4160.00	14000.0	10000.0
	Pos. Seq. Z%:	0.316 + J 5.29	(Zpu 0.031 + j 0.529)			Shell Type
	Zero Seq. Z%:	0.316 + J 5.29	(Sec 104.0 + j 0.529 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.
	Secondary Neutral Z:	6.00 + J 0.000 Ohms				
T8B	BUS-0131	D 12470.0	T8B SEC	YG 4160.00	14000.0	10000.0
	Pos. Seq. Z%:	0.316 + J 5.29	(Zpu 0.031 + j 0.529)			Shell Type
	Zero Seq. Z%:	0.316 + J 5.29	(Sec 104.0 + j 0.529 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.
	Secondary Neutral Z:	6.00 + J 0.000 Ohms				
TA	BUS-0116	D 4160.00	BUS-0121	YG 480.00	150.00	150.00
	Pos. Seq. Z%:	1.94 + J 4.07	(Zpu 12.93 + j 27.13)			Shell Type
	Zero Seq. Z%:	1.94 + J 4.07	(Sec 12.93 + j 27.13 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.
TB	BUS-0117	D 4160.00	BUS-0120	YG 480.00	150.00	150.00
	Pos. Seq. Z%:	1.94 + J 4.07	(Zpu 12.93 + j 27.13)			Shell Type
	Zero Seq. Z%:	1.94 + J 4.07	(Sec 12.93 + j 27.13 Pri Open)			
	Taps Pri. 0.000 %	Sec. 0.000 %	Phase Shift (Pri. Leading Sec.):			30.00 Deg.

Northeast Water Purification Plant

All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

VFD INPUT DATA

VFD NAME	VFD FROM NAME	VFD TO NAME	VOLTS	RATING	--CONTRIBUTION% OF RATING--			-----BYPASS IMPEDAN		
					THREE PHASE	LINE-G	X/R	Z1%	X1/R1	Z0%
ASD-05P01	05P01 VFD	BUS-0087		400						
ASD-05P02	05P02 VFD	BUS-0091		400						
ASD-02P01	02P01 VFD	BUS-0095		300						
ASD-02P02	02P02 VFD	BUS-0096		300						
ASD 08-P-8	BUS-0134	BUS-0110		800						
ASD 08-P-2	BUS-0112	BUS-0113		800						
ASD 08-P-1	BUS-0114	BUS-0115		800						
ASD-05P201	SWBD 7A	BUS-0132		400						
ASD-05P202	SWBD 7B	BUS-0133		400						

VFD INPUT DATA

VFD NAME	VFD FROM NAME	VFD TO NAME	VOLTS	RATING	--CONTRIBUTION% OF RATING--			-----BYPASS IMPEDAN		
					THREE PHASE	LINE-G	X/R	Z1%	X1/R1	Z0%

GENERATION CONTRIBUTION DATA

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=====
BUS          CONTRIBUTION  VOLTAGE
NAME        NAME          L-L      MVA      X"d     X/R
=====
CNP 138 kV  CNP              138000. 3773.98
              Three Phase      Contribution:  3773.98 MVA      9.79
              Single Line to Ground Contribution:  798.24 MVA      6.72
              Pos Sequence Impedance (100 MVA Base)  0.0027 + J    0.0264 PU
              Zero Sequence Impedance (100 MVA Base)  0.0131 + J    0.0712 PU
    
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MOTOR CONTRIBUTION DATA

BUS NAME	CONTRIBUTION NAME	VOLTAGE L-L	BASE kVA	X"d	X/R	Motor Number
02-P-01 TERM	02-P-01	480	292.87	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				5.33 + j	53.31 PU
02-P-02 TERM	02-P-02	480	292.87	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				5.33 + j	53.31 PU
02-P-03 TERM	02-P-03	480	292.14	0.1515	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				4.76 + j	47.63 PU
02-P-03 TERMO	02-P-04	480	292.14	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				5.34 + j	53.44 PU
02-P-05 TERM	02-P-05	480	292.14	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				5.34 + j	53.44 PU
04-ME-01 TERM	04-ME-01	480	112.83	0.1692	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				13.77 + j	137.73 PU
04-ME-02 TERM	04-ME-02	480	112.83	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				13.84 + j	138.38 PU
05-P-01 TERM	05-P-01	480	372.37	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				4.19 + j	41.93 PU
05-P-02 TERM	05-P-02	480	372.37	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				4.19 + j	41.93 PU
05-P-03 TERM	05-P-03	480	372.37	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				4.19 + j	41.93 PU

MOTOR CONTRIBUTION DATA

BUS NAME	CONTRIBUTION NAME	VOLTAGE L-L	BASE kVA	X"d	X/R	Motor Number
08-P-01 TERM	08-P-1	4160	771.36	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.04 PU
08-P-02 TERM	08-P-3	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
08-P-03 TERM	08-P-2	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
08-P-04 TERM	08-P-4	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
08-P-05 TERM	08-P-6	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
08-P-07 TERM	08-P-7	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
08-P-8-TERM	08-P-8	4160	772.32	0.17	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)				2.20 + j	22.01 PU
BUS-0132	05-P-201	480	466.25	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)				10.94 + j	34.79 PU
BUS-0133	05-P-202	480	466.25	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)				10.94 + j	34.79 PU
MCC-1A	MCC1A-GRP	480	62.94	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)				81.04 + j	257.69 PU

MOTOR CONTRIBUTION DATA

BUS NAME	CONTRIBUTION NAME	VOLTAGE L-L	BASE kVA	X"d	X/R	Motor Number
MCC-1B	MCC1B-GRP	480	62.36	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			81.80 + j		260.10 PU
MCC-2A	MCC2A-GRP	480	16.32	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			312.58 + j		993.95 PU
MCC-2B	MCC2B-GRP	480	29.14	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			175.05 + j		556.61 PU
MCC-2C	MCC2C-GRP	480	64.11	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			79.57 + j		253.01 PU
MCC-2D	MCC2D-GRP	480	92.08	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			55.39 + j		176.14 PU
MCC3A	MCC3A-GRP	480	142.21	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			35.87 + j		114.06 PU
MCC3B	MCC3B-GRP	480	121.22	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			42.08 + j		133.80 PU
SWBD 7A	04-ME-201	480	233.13	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			21.88 + j		69.58 PU
SWBD 7A	05-P-203	480	466.25	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			10.94 + j		34.79 PU
SWBD 7B	04-ME-202	480	233.13	0.1622	3.18	1.00
	Pos Sequence Impedance (100 MVA Base)			21.88 + j		69.58 PU

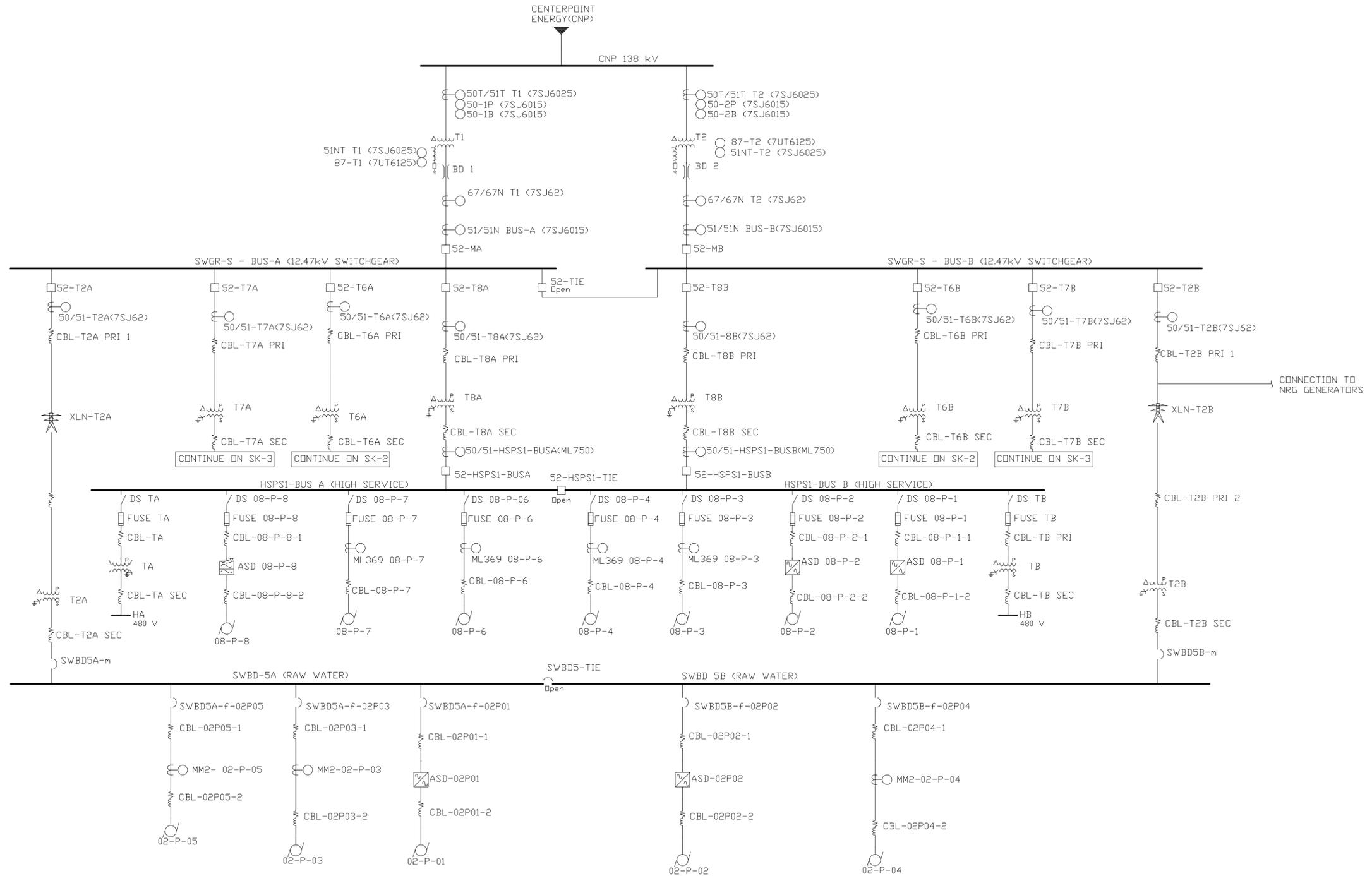
2.4 SKM One-Line Diagrams

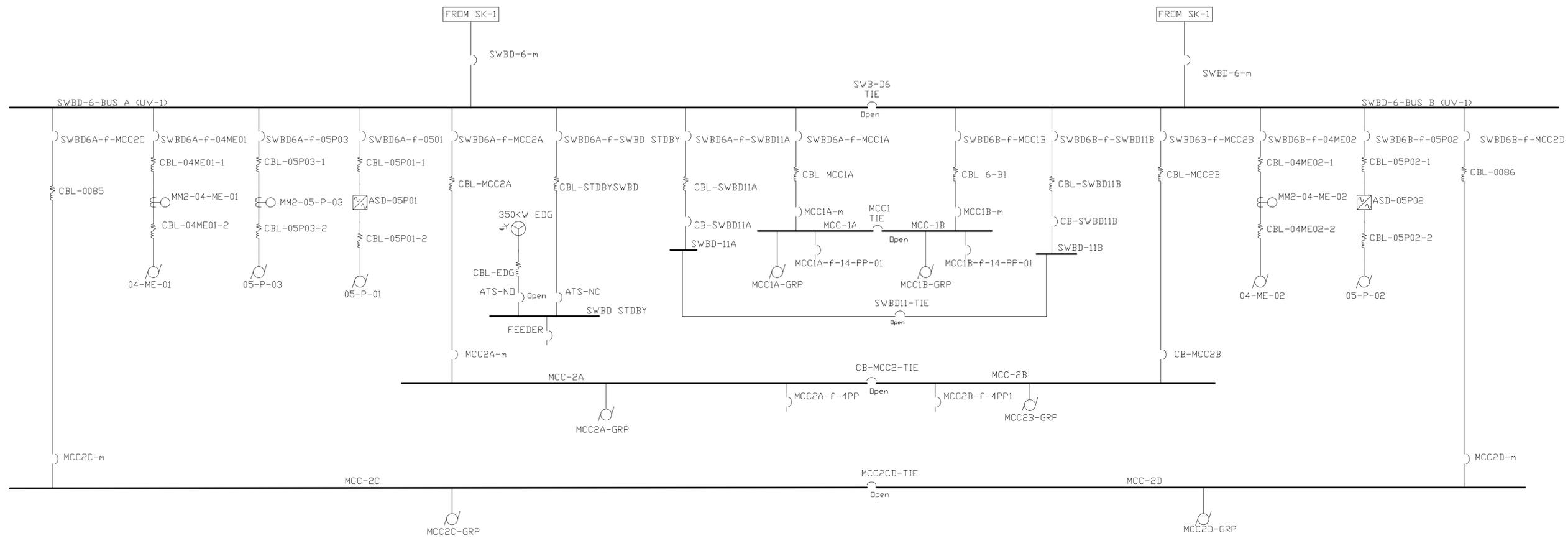
The below listed computer model one line diagrams follow this page.

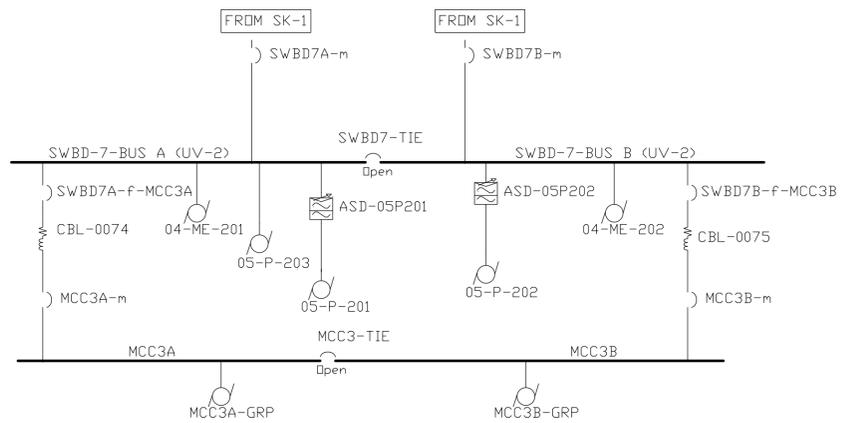
SK-1: 12.47 kV Switchgear, High Service & Raw Water One Line Diagram

SK-2: UV Building No. 1 One Line Diagram

SK-3: UV Building No. 2 One Line Diagram







Section 3

Short Circuit Study

3.1 Description of Study

The short circuit study determines the fault (short circuit) currents that flow in the system during various fault conditions. The calculated fault currents are used in the device evaluation and coordination studies.

The short circuit calculations were performed using A_FAULT, a computer software package by SKM Systems Analysis. The short circuit analysis performed by A_FAULT conforms to and is based on ANSI Standards C37.010, C37.5 and C37.13.

Separate “Z” (complex), “X” (reactive), and “R” (resistive) networks are used by A_FAULT for the short circuit analysis. The X/R ratios calculated for each fault condition are based on the separate reduction of the X and R networks. These X/R ratios are used for the calculation of fault duty multipliers, which are used in the evaluation of the short circuit ratings of system components. A_FAULT uses the relationship E/Z to calculate the fault current magnitude and angle at each faulted bus. The complex equivalent circuit impedance, Z, is calculated by the separate reduction of the “Z” (complex) network, and is reported as the “EQUIV, IMPEDANCE” in the A_FAULT reports.

A_FAULT is capable of generating three types of short circuit reports for both balanced (three phase bolted) and unbalanced (line to ground) faults. The reports that are generated depend on the system that is being evaluated.

The three types of short circuit reports are:

- Momentary Duty Report (for medium voltage)
- Interrupting Duty Report (for medium voltage)
- Fault Report (for low voltage)

3.1.1 Momentary Duty Report

The “Momentary Duty Report” contains the calculated fault currents that occur during the first half cycle of the fault. The fault currents reported in the “Momentary Duty Report” are calculated as follows:

- Motor and generator sub-transient reactances (X_d'') are adjusted per the first cycle duty multipliers described in IEEE std. 141-1993.
- The complex equivalent circuit impedance, Z , is calculated by network reduction of the “ Z ” (complex) network.
- The momentary symmetrical current = E/Z .
- The X/R ratio reported is equal to the equivalent circuit reactance, X , divided by the equivalent circuit resistance, R . As discussed above, X is calculated by the reduction of the “ X ” (reactive) network and R is calculated by the reduction of the “ R ” (resistive) network.
- A_FAULT calculates and reports the momentary asymmetrical current in two different ways. Once as “sym*1.6” and again as “momentary based on X/R”. The “sym*1.6” value is the momentary symmetrical current multiplied by 1.6. The “momentary based on X/R” value is the momentary symmetrical current multiplied by $\sqrt{1+2e^{(-2\pi/X/R)}}$.

3.1.2 Interrupting Duty Report

The fault currents reported in the “Interrupting Duty Report” are used to evaluate medium voltage breakers. The interrupting symmetrical current is calculated as follows:

- Motor and generator sub-transient reactances (X_d'') are adjusted per the interrupting duty multipliers described in IEEE std. 141-1993.
- The complex equivalent circuit impedance, Z , is calculated by network reduction of the “ Z ” (complex) network.
- The interrupting symmetrical current = E/Z .
- The X/R ratio reported is equal to the equivalent circuit reactance, X , divided by the equivalent circuit resistance, R . As discussed above, X is calculated by the reduction of the “ X ” (reactive) network and R is calculated by the reduction of the “ R ” (resistive) network.

A_FAULT determines the minimum contact parting time multiplying factors for 2, 3, 5, and 8 cycle breakers and then calculates the resulting interrupting asymmetrical fault currents for each type of breaker. The multiplying factors are based on ANSI C37.5-1979 and C37.010-1979 standards.

NACD (No AC Decrement) ratios are calculated with consideration of generator "Local" and "Remote" contributions as outlined in ANSI Standard C37.010-1979.

3.1.3 Fault Report

The fault currents reported in the “Fault Report” apply to low-voltage devices and components. The fault currents calculated in this report are based on the contribution data derived from ANSI C37.13. The fault currents are calculated as follows:

- Motor and generator sub-transient reactances (X_d'') are adjusted per the first cycle duty multipliers described in IEEE std. 141-1993.
- The complex equivalent circuit impedance, Z , is calculated by network reduction of the “ Z ” (complex) network.
- The momentary symmetrical current = E/Z .
- The X/R ratio is equal to the equivalent circuit reactance, X , divided by the equivalent circuit resistance, R . As discussed above, X is calculated by the reduction of the “ X ” (reactive) network and R is calculated by the reduction of the “ R ” (resistive) network.

True asymmetrical currents are not calculated for this report. Instead multiplying factors are determined and used to “adjust” the calculated symmetrical fault current. The “adjusted” current is used to evaluate low voltage protective devices. Low voltage output algorithms and output reports reflect NEMA AB-1 molded case breaker de-rating multipliers. Breakers are de-rated for circuits where the power factor is lower than the NEMA test circuit (higher X/R ratio). The multipliers adjust the symmetrical fault current to the value associated with the systems fault point X/R ratio. The adjusted value listed on the report may then be compared directly with the manufacturer's published interrupting rating.

Motor and generator impedance multipliers for the short circuit calculations are summarized as follows (from ANSI/IEEE Standard 141-1993 Red Book):

<u>Machine Type</u>	<u>Impedance (First Cycle Duty)</u>	<u>Impedance (Interrupting Duty)</u>
Turbine generators, Condensers,	1.0 Xd"	1.0 Xd"
Hydro generators with Amortisseur windings,	0.75 Xd'	0.75 Xd'
Synchronous motors	1.0 Xd"	1.5 Xd"
Induction motors > 1000 hp at speed 1800 RPM, or > 250 hp at 3600 RPM.	1.0 Xd"	1.5 Xd"
Induction motors >50 hp not covered above.	1.2 Xd"	3.0 Xd"
Induction motors < 50 hp	1.67 Xd"	Neglect

Note: Xd" for typical induction motors is approximately 17%.

3.2 Short Circuit Study Results

The following short circuit study reports follow this page.

- Three Phase Fault Report
- Unbalanced Fault Report
- Fault Study Summary Report
- Three Phase Momentary Duty Report
- Unbalanced Momentary Duty Report
- Momentary Duty Summary Report
- Three Phase Interrupting Duty Report
- Unbalanced Interrupting Duty Report
- Interrupting Duty Summary Report

Northeast Water Purification Plant
All MV & LV Switchgear Tie Breakers OPEN; Normal Operating Condition

Mar 30, 2014 17:54:31

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY
SKM DISCLAIMS ANY RESPONSIBILITY AND LIABILITY RESULTING
FROM THE USE AND INTERPRETATION OF THIS SOFTWARE.

SKM POWER*TOOLS FOR WINDOWS
A_FAULT SHORT CIRCUIT ANALYSIS REPORT
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THREE PHASE FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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12.47kV BUS-A 3P Duty: 6.699 KA AT -85.90 DEG ( 144.69 MVA) X/R: 15.45
                VOLTAGE: 12470. EQUIV. IMPEDANCE= 0.0769 + J 1.0720 OHMS
                CBL-T2A PRI 1 T2A POLE 1 0.134 KA ANG: -263.04
                CBL-T6A PRI BUS-0125 0.126 KA ANG: -260.54
                CBL-T7A PRI BUS-0127 0.163 KA ANG: -253.30
                CBL-T8A PRI BUS-0130 0.333 KA ANG: -263.90
                BD 1 TR1 SEC 5.948 KA ANG: 93.47

12.47kV BUS-B 3P Duty: 6.469 KA AT -86.14 DEG ( 139.72 MVA) X/R: 15.79
                VOLTAGE: 12470. EQUIV. IMPEDANCE= 0.0750 + J 1.1104 OHMS
                CBL-T2B PRI 1 T2B POLE 1 0.067 KA ANG: -263.41
                CBL-T6B PRI BUS-0126 0.054 KA ANG: -256.73
                CBL-T7B PRI BUS-0129 0.069 KA ANG: -252.86
                CBL-T8B PRI BUS-0131 0.334 KA ANG: -263.89
                BD 2 TR2 SEC 5.948 KA ANG: 93.47

CNP 138 kV 3P Duty: 15.893 KA AT -84.15 DEG (3798.89 MVA) X/R: 9.78
                VOLTAGE: 138000. EQUIV. IMPEDANCE= 0.5109 + J 4.9869 OHMS
                CONTRIBUTIONS: CNP 15.789 KA ANG: -84.17
                T1 TR1 SEC 0.061 KA ANG: -81.53
                T2 TR2 SEC 0.044 KA ANG: -82.03

HA 3P Duty: 3.729 KA AT -63.99 DEG ( 3.10 MVA) X/R: 2.05
                VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0326 + J 0.0668 OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER 3.729 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA 3.900 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA 3.729 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA 3.729 KA
                CBL-TA SEC BUS-0121 3.729 KA ANG: 116.01

HB 3P Duty: 3.727 KA AT -64.01 DEG ( 3.10 MVA) X/R: 2.05
                VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0326 + J 0.0668 OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER 3.727 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA 3.898 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA 3.727 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA 3.727 KA
                CBL-TB SEC BUS-0120 3.727 KA ANG: 115.99

HSPS1-BUSA 3P Duty: 11.981 KA AT -85.76 DEG ( 86.33 MVA) X/R: 14.38
                VOLTAGE: 4160. EQUIV. IMPEDANCE= 0.0148 + J 0.1999 OHMS
                CBL-08-P-7 08-P-07 TERM 0.520 KA ANG: -263.81
                CBL-08-P-6 08-P-05 TERM 0.520 KA ANG: -263.82
                CBL-T8A SEC T8A SEC 10.942 KA ANG: 94.06
    
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THREE PHASE FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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CONTRIBUTIONS TO HSPS1-BUSA (CONTINUED)

HSPS1-BUSB  3P Duty: 11.765 KA AT -85.93 DEG ( 84.77 MVA) X/R: 14.74
VOLTAGE: 4160. EQUIV. IMPEDANCE= 0.0145 + J 0.2036 OHMS
CBL-08-P-3   08-P-02 TERM      0.520 KA    ANG: -263.82
CBL-08-P-4   08-P-04 TERM      0.520 KA    ANG: -263.80
CBL-T8B SEC   T8B SEC              10.726 KA   ANG: -86.14

MCC-1A      3P Duty: 12.801 KA AT -63.39 DEG ( 10.64 MVA) X/R: 2.01
VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0097 + J 0.0194 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 12.801 KA
MOLDED CASE CIRCUIT BREAKER < 20KA 12.801 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 12.801 KA
CONTRIBUTIONS: MCC1A-GRP      0.267 KA    ANG: -72.54
CBL MCC1A     SWBD-6A        12.537 KA   ANG: -63.20

MCC-1B      3P Duty: 12.562 KA AT -63.68 DEG ( 10.44 MVA) X/R: 2.03
VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0098 + J 0.0198 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 12.562 KA
MOLDED CASE CIRCUIT BREAKER < 20KA 12.562 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 12.562 KA
CONTRIBUTIONS: MCC1B-GRP      0.264 KA    ANG: -72.54
CBL 6-B1     SWBD-6B        12.301 KA   ANG: -63.49

MCC-2A      3P Duty: 30.172 KA AT -75.91 DEG ( 25.08 MVA) X/R: 4.02
VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0022 + J 0.0089 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 30.172 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 30.172 KA
CONTRIBUTIONS: MCC2A-GRP      0.069 KA    ANG: -72.54
CBL-MCC2A    SWBD-6A        30.103 KA   ANG: -75.92

MCC-2B      3P Duty: 29.854 KA AT -78.14 DEG ( 24.82 MVA) X/R: 4.81
VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0019 + J 0.0091 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 29.854 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 29.854 KA
CONTRIBUTIONS: MCC2B-GRP      0.123 KA    ANG: -72.54
CBL-MCC2B    SWBD-6B        29.732 KA   ANG: -78.16

MCC-2C      3P Duty: 28.033 KA AT -75.38 DEG ( 23.31 MVA) X/R: 3.86
VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0025 + J 0.0096 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 28.033 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 28.033 KA
CONTRIBUTIONS: MCC2C-GRP      0.272 KA    ANG: -72.54
CBL-0085     SWBD-6A        27.762 KA   ANG: -75.41
    
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T H R E E P H A S E F A U L T R E P O R T
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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MCC-2D      3P Duty: 26.908 KA AT -75.54 DEG ( 22.37 MVA) X/R: 3.90
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0026 + J 0.0100 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 26.908 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 26.908 KA
            CONTRIBUTIONS: MCC2D-GRP 0.390 KA ANG: -72.54
            CBL-0086 SWBD-6B 26.518 KA ANG: -75.58

MCC3A      3P Duty: 32.649 KA AT -75.24 DEG ( 27.14 MVA) X/R: 3.90
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0022 + J 0.0082 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 32.649 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 32.649 KA
            CONTRIBUTIONS: MCC3A-GRP 0.602 KA ANG: -72.54
            CBL-0074 SWBD 7A 32.047 KA ANG: -75.30

MCC3B      3P Duty: 30.086 KA AT -76.19 DEG ( 25.01 MVA) X/R: 4.12
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0022 + J 0.0089 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 30.086 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 30.086 KA
            CONTRIBUTIONS: MCC3B-GRP 0.514 KA ANG: -72.54
            CBL-0075 SWBD 7B 29.573 KA ANG: -76.25

SWBD 5B    3P Duty: 28.798 KA AT -78.66 DEG ( 23.94 MVA) X/R: 5.12
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0019 + J 0.0094 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 28.798 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 29.081 KA
            CBL-02P04-1 02P04 RVSSS 1.839 KA ANG: 96.21
            CBL-T2B SEC T2B SEC 26.967 KA ANG: -78.31

SWBD 7A    3P Duty: 37.590 KA AT -80.08 DEG ( 31.25 MVA) X/R: 6.03
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0013 + J 0.0073 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 37.590 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 39.242 KA
            CONTRIBUTIONS: 05-P-203 2.749 KA ANG: -72.54
                        04-ME-201 1.374 KA ANG: -72.54
            CBL-0074 MCC3A 0.601 KA ANG: -252.47
            CBL-T7A SEC BUS-0080 32.913 KA ANG: -81.16

SWBD 7B    3P Duty: 34.203 KA AT -80.73 DEG ( 28.44 MVA) X/R: 6.29
            VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0013 + J 0.0080 OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER 34.203 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA 36.003 KA
            CONTRIBUTIONS: 04-ME-202 1.374 KA ANG: -72.54
            CBL-0075 MCC3B 0.512 KA ANG: -252.48
    
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THREE PHASE FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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CONTRIBUTIONS TO SWBD 7B      (CONTINUED)
CBL-T7B SEC      BUS-0078      32.336 KA      ANG:  -81.20

SWBD STDBY      3P Duty: 31.765 KA AT  -77.61 DEG ( 26.41 MVA) X/R:  4.60
VOLTAGE:  480.  EQUIV. IMPEDANCE= 0.0019 + J 0.0085 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 31.765 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 31.765 KA
CBL-STDBYSWBD  SWBD-6A      31.765 KA      ANG:  -77.61

SWBD-11A      3P Duty: 9.046 KA AT  -46.68 DEG ( 7.52 MVA) X/R:  1.06
VOLTAGE:  480.  EQUIV. IMPEDANCE= 0.0210 + J 0.0223 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 9.046 KA
MOLDED CASE CIRCUIT BREAKER < 10KA 9.046 KA
MOLDED CASE CIRCUIT BREAKER < 20KA 9.046 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 9.046 KA
CBL-SWBD11A  SWBD-6A      9.046 KA      ANG:  -46.68

SWBD-11B      3P Duty: 8.938 KA AT  -47.10 DEG ( 7.43 MVA) X/R:  1.08
VOLTAGE:  480.  EQUIV. IMPEDANCE= 0.0211 + J 0.0227 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 8.938 KA
MOLDED CASE CIRCUIT BREAKER < 10KA 8.938 KA
MOLDED CASE CIRCUIT BREAKER < 20KA 8.938 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 8.938 KA
CBL-SWBD11B  SWBD-6B      8.938 KA      ANG:  -47.10

SWBD-5A      3P Duty: 30.990 KA AT  -79.13 DEG ( 25.76 MVA) X/R:  5.45
VOLTAGE:  480.  EQUIV. IMPEDANCE= 0.0017 + J 0.0088 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 30.990 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 31.705 KA
CBL-02P03-1  02P03 RVSSS      2.060 KA      ANG:  96.27
CBL-02P05-1  02P05 RVSSS      1.839 KA      ANG:  96.21
CBL-T2A SEC  T2A SEC      27.105 KA      ANG:  -78.47

SWBD-6A      3P Duty: 35.447 KA AT  -81.65 DEG ( 29.47 MVA) X/R:  6.93
VOLTAGE:  480.  EQUIV. IMPEDANCE= 0.0011 + J 0.0077 OHMS
LOW VOLTAGE POWER CIRCUIT BREAKER 35.765 KA
MOLDED CASE CIRCUIT BREAKER > 20KA 37.973 KA
CBL-0085      MCC-2C      0.271 KA      ANG:  -252.50
CBL-MCC2A     MCC-2A      0.069 KA      ANG:  -252.53
CBL MCC1A     MCC-1A      0.263 KA      ANG:  -252.28
CBL-05P03-1  05P03 RVSSS      2.277 KA      ANG:  97.56
CBL-T6A SEC  T6A SEC      31.882 KA      ANG:  -81.77
CBL-04ME01-1 04ME01 RVSSS      0.693 KA      ANG:  -261.24
    
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T H R E E P H A S E F A U L T R E P O R T
(FOR APPLICATION OF LOW VOLTAGE BREAKERS)
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

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SWBD-6B	3P Duty: 33.588 KA AT -81.48 DEG (27.92 MVA) X/R: 6.79
	VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0012 + J 0.0082 OHMS
	LOW VOLTAGE POWER CIRCUIT BREAKER 33.764 KA
	MOLDED CASE CIRCUIT BREAKER > 20KA 35.849 KA
CBL-0086	MCC-2D 0.389 KA ANG: -252.48
CBL-MCC2B	MCC-2B 0.123 KA ANG: -252.53
CBL 6-B1	MCC-1B 0.261 KA ANG: -252.28
CBL-T6B SEC	T6B SEC 32.135 KA ANG: -81.70
CBL-04ME02-1	04ME02 RVSSS 0.690 KA ANG: -261.26

UNBALANCED FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

LOCATION VOLTAGE	FAULT DUTIES	KA (RMS)	X/R	EQUIVALENT (PU) FAULT IMPEDANCE	ASYM. KA AT 0.5 CYCLES * MAX. RMS	AVG. RMS *
12.47kV BUS-A	3P Duty:	6.699	15.	Z1= 0.6911	10.229	8.566
	SLG DUTY:	0.398	0.	Z2= 0.6911	0.398	
12470. VOLTS	LN/LN:	5.802		Z0= 34.7677		
	LN/LN/GND:	5.901 (	0.200	GND RETURN KA)		
12.47kV BUS-B	3P Duty:	6.469	16.	Z1= 0.7157	9.903	8.286
	SLG DUTY:	0.398	0.	Z2= 0.7157	0.398	
12470. VOLTS	LN/LN:	5.602		Z0= 34.7677		
	LN/LN/GND:	5.702 (	0.200	GND RETURN KA)		
CNP 138 kV	3P Duty:	15.893	10.	Z1= 0.0263	22.766	19.496
	SLG DUTY:	10.047	7.	Z2= 0.0263	13.419	
138000. VOLTS	LN/LN:	13.764		Z0= 0.0724		
	LN/LN/GND:	14.481 (	7.339	GND RETURN KA)		
HA	3P Duty:	3.729	2.	Z1= 32.2514	3.900	3.815
	SLG DUTY:	3.724	2.	Z2= 32.2514	3.887	
480. VOLTS	LN/LN:	3.230		Z0= 32.4060		
	LN/LN/GND:	3.744 (	3.718	GND RETURN KA)		
HB	3P Duty:	3.727	2.	Z1= 32.2698	3.898	3.813
	SLG DUTY:	3.722	2.	Z2= 32.2698	3.885	
480. VOLTS	LN/LN:	3.228		Z0= 32.4060		
	LN/LN/GND:	3.743 (	3.717	GND RETURN KA)		
HSPS1-BUSA	3P Duty:	11.981	14.	Z1= 1.1584	18.138	15.233
	SLG DUTY:	0.399	0.	Z2= 1.1584	0.399	
4160. VOLTS	LN/LN:	10.376		Z0= 104.0498		
	LN/LN/GND:	10.476 (	0.200	GND RETURN KA)		
HSPS1-BUSB	3P Duty:	11.765	15.	Z1= 1.1796	17.865	14.988
	SLG DUTY:	0.399	0.	Z2= 1.1796	0.399	
4160. VOLTS	LN/LN:	10.189		Z0= 104.0481		
	LN/LN/GND:	10.289 (	0.200	GND RETURN KA)		
MCC-1A	3P Duty:	12.801	2.	Z1= 9.3966	13.347	13.075
	SLG DUTY:	9.739	2.	Z2= 9.3966	10.326	
480. VOLTS	LN/LN:	11.086		Z0= 18.3013		
	LN/LN/GND:	11.476 (	7.850	GND RETURN KA)		

UNBALANCED FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

LOCATION VOLTAGE	FAULT DUTIES	KA (RMS)	X/R	EQUIVALENT (PU) FAULT IMPEDANCE	ASYM. KA AT 0.5 CYCLES * MAX. RMS	AVG. RMS *
MCC-1B	3P Duty:	12.562	2.	Z1= 9.5748	13.120	12.842
	SLG DUTY:	9.657	2.	Z2= 9.5748	10.247	
480. VOLTS	LN/LN:	10.879		Z0= 18.2527		
	LN/LN/GND:	11.299	(	7.836 GND RETURN KA)		
MCC-2A	3P Duty:	30.172	4.	Z1= 3.9865	35.935	33.119
	SLG DUTY:	28.536	4.	Z2= 3.9865	33.583	
480. VOLTS	LN/LN:	26.130		Z0= 4.6735		
	LN/LN/GND:	29.693	(	27.066 GND RETURN KA)		
MCC-2B	3P Duty:	29.854	5.	Z1= 4.0289	37.063	33.561
	SLG DUTY:	29.102	5.	Z2= 4.0289	35.780	
480. VOLTS	LN/LN:	25.855		Z0= 4.3420		
	LN/LN/GND:	29.685	(	28.385 GND RETURN KA)		
MCC-2C	3P Duty:	28.033	4.	Z1= 4.2907	33.075	30.608
	SLG DUTY:	25.518	4.	Z2= 4.2907	29.955	
480. VOLTS	LN/LN:	24.277		Z0= 5.5595		
	LN/LN/GND:	27.048	(	23.417 GND RETURN KA)		
MCC-2D	3P Duty:	26.908	4.	Z1= 4.4701	31.827	29.421
	SLG DUTY:	24.972	4.	Z2= 4.4701	29.350	
480. VOLTS	LN/LN:	23.303		Z0= 5.5100		
	LN/LN/GND:	26.173	(	23.296 GND RETURN KA)		
MCC3A	3P Duty:	32.649	4.	Z1= 3.6841	38.622	35.701
	SLG DUTY:	30.974	4.	Z2= 3.6841	36.424	
480. VOLTS	LN/LN:	28.275		Z0= 4.2819		
	LN/LN/GND:	31.978	(	29.462 GND RETURN KA)		
MCC3B	3P Duty:	30.086	4.	Z1= 3.9980	36.040	33.133
	SLG DUTY:	29.274	4.	Z2= 3.9980	34.724	
480. VOLTS	LN/LN:	26.055		Z0= 4.3315		
	LN/LN/GND:	29.914	(	28.503 GND RETURN KA)		
SWBD 5B	3P Duty:	28.798	5.	Z1= 4.1767	36.275	32.650
	SLG DUTY:	31.433	5.	Z2= 4.1767	40.071	
480. VOLTS	LN/LN:	24.940		Z0= 3.1284		
	LN/LN/GND:	30.000	(	34.592 GND RETURN KA)		

UNBALANCED FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

LOCATION VOLTAGE	FAULT DUTIES	KA (RMS)	X/R	EQUIVALENT (PU) FAULT IMPEDANCE	ASYM. KA AT 0.5 CYCLES * MAX. RMS	AVG. RMS *
SWBD 7A	3P Duty:	37.590	6.	Z1= 3.1999	49.083	43.540
	SLG DUTY:	38.042	6.	Z2= 3.1999	49.716	
480. VOLTS	LN/LN:	32.553		Z0= 3.0857		
	LN/LN/GND:	37.704	(	38.506 GND RETURN KA)		
SWBD 7B	3P Duty:	34.203	6.	Z1= 3.5167	45.076	39.838
	SLG DUTY:	35.484	6.	Z2= 3.5167	46.676	
480. VOLTS	LN/LN:	29.620		Z0= 3.1357		
	LN/LN/GND:	34.890	(	36.866 GND RETURN KA)		
SWBD STDBY	3P Duty:	31.765	5.	Z1= 3.7866	39.035	35.498
	SLG DUTY:	30.682	4.	Z2= 3.7866	37.216	
480. VOLTS	LN/LN:	27.510		Z0= 4.1888		
	LN/LN/GND:	31.537	(	29.668 GND RETURN KA)		
SWBD-11A	3P Duty:	9.046	1.	Z1= 13.2964	9.070	9.058
	SLG DUTY:	7.152	1.	Z2= 13.2964	7.189	
480. VOLTS	LN/LN:	7.834		Z0= 23.9475		
	LN/LN/GND:	8.110	(	5.904 GND RETURN KA)		
SWBD-11B	3P Duty:	8.938	1.	Z1= 13.4568	8.964	8.951
	SLG DUTY:	7.112	1.	Z2= 13.4568	7.149	
480. VOLTS	LN/LN:	7.741		Z0= 23.9036		
	LN/LN/GND:	8.041	(	5.896 GND RETURN KA)		
SWBD-5A	3P Duty:	30.990	5.	Z1= 3.8813	39.581	35.424
	SLG DUTY:	33.136	6.	Z2= 3.8813	42.704	
480. VOLTS	LN/LN:	26.838		Z0= 3.1284		
	LN/LN/GND:	31.903	(	35.597 GND RETURN KA)		
SWBD-6A	3P Duty:	35.447	7.	Z1= 3.3932	47.656	41.793
	SLG DUTY:	36.006	7.	Z2= 3.3932	48.010	
480. VOLTS	LN/LN:	30.698		Z0= 3.2356		
	LN/LN/GND:	35.893	(	36.581 GND RETURN KA)		
SWBD-6B	3P Duty:	33.588	7.	Z1= 3.5811	44.966	39.498
	SLG DUTY:	34.872	7.	Z2= 3.5811	46.374	
480. VOLTS	LN/LN:	29.088		Z0= 3.1857		
	LN/LN/GND:	34.402	(	36.258 GND RETURN KA)		

F A U L T S T U D Y S U M M A R Y
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

BUS RECORD NO NAME	VOLTAGE A V A I L A B L E		F A U L T D U T I E S (KA)		
	L-L	3 PHASE	X/R	LINE/GRND	X/R
12.47kV BUS-A	12470.	6.699	15.45	0.398	0.06
12.47kV BUS-B	12470.	6.469	15.79	0.398	0.06
CNP 138 kV	138000.	15.893	9.78	10.047	6.71
HA	480.	3.729	2.05	3.724	2.02
HB	480.	3.727	2.05	3.722	2.02
=====					
HSPS1-BUSA	4160.	11.981	14.38	0.399	0.03
HSPS1-BUSB	4160.	11.765	14.74	0.399	0.03
MCC-1A	480.	12.801	2.01	9.739	2.26
MCC-1B	480.	12.562	2.03	9.657	2.27
MCC-2A	480.	30.172	4.02	28.536	3.81
MCC-2B	480.	29.854	4.81	29.102	4.61
MCC-2C	480.	28.033	3.86	25.518	3.77
MCC-2D	480.	26.908	3.90	24.972	3.79
MCC3A	480.	32.649	3.90	30.974	3.80
MCC3B	480.	30.086	4.12	29.274	3.95
SWBD 5B	480.	28.798	5.12	31.433	5.40
SWBD 7A	480.	37.590	6.03	38.042	6.05
SWBD 7B	480.	34.203	6.29	35.484	6.24
SWBD STDBY	480.	31.765	4.60	30.682	4.35
SWBD-11A	480.	9.046	1.06	7.152	1.19
SWBD-11B	480.	8.938	1.08	7.112	1.20
SWBD-5A	480.	30.990	5.45	33.136	5.67
SWBD-6A	480.	35.447	6.93	36.006	6.65
SWBD-6B	480.	33.588	6.79	34.872	6.57

89 FAULTED BUSES, 119 BRANCHES, 31 CONTRIBUTIONS
 UNBALANCED FAULTS REQUESTED

*** SHORT CIRCUIT STUDY COMPLETE ***

T H R E E P H A S E M O M E N T A R Y D U T Y R E P O R T
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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12.47kV BUS-A E/Z:      6.699 KA AT  -85.90 DEG ( 144.69 MVA) X/R:   15.45
              SYM*1.6:  10.718 KA      MOMENTARY BASED ON X/R:  10.229 KA
              SYM*2.7:  18.087 KA      CREST BASED ON X/R:   17.204 KA
              VOLTAGE:  12470.  EQUIV. IMPEDANCE=  0.0769 + J  1.0720 OHMS
              CBL-T2A PRI 1  T2A POLE 1      0.134 KA      ANG:  -263.04
              CBL-T6A PRI   BUS-0125       0.126 KA      ANG:  -260.54
              CBL-T7A PRI   BUS-0127       0.163 KA      ANG:  -253.30
              CBL-T8A PRI   BUS-0130       0.333 KA      ANG:  -263.90
              BD 1          TR1 SEC         5.948 KA      ANG:   93.47

12.47kV BUS-B E/Z:      6.469 KA AT  -86.14 DEG ( 139.72 MVA) X/R:   15.79
              SYM*1.6:  10.351 KA      MOMENTARY BASED ON X/R:  9.903 KA
              SYM*2.7:  17.467 KA      CREST BASED ON X/R:   16.647 KA
              VOLTAGE:  12470.  EQUIV. IMPEDANCE=  0.0750 + J  1.1104 OHMS
              CBL-T2B PRI 1  T2B POLE 1      0.067 KA      ANG:  -263.41
              CBL-T6B PRI   BUS-0126       0.054 KA      ANG:  -256.73
              CBL-T7B PRI   BUS-0129       0.069 KA      ANG:  -252.86
              CBL-T8B PRI   BUS-0131       0.334 KA      ANG:  -263.89
              BD 2          TR2 SEC         5.948 KA      ANG:   93.47
    
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T H R E E P H A S E M O M E N T A R Y D U T Y R E P O R T
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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CNP 138 kV  E/Z:      15.893 KA AT  -84.15 DEG (3798.89 MVA) X/R:      9.78
            SYM*1.6:  25.429 KA      MOMENTARY BASED ON X/R:  22.766 KA
            SYM*2.7:  42.912 KA      CREST BASED ON X/R:   38.776 KA
            VOLTAGE: 138000.  EQUIV. IMPEDANCE= 0.5109 + J 4.9869 OHMS
            CONTRIBUTIONS: CNP      15.789 KA      ANG:   -84.17
            T1         TR1 SEC      0.061 KA      ANG:   -81.53
            T2         TR2 SEC      0.044 KA      ANG:   -82.03

HA          VOLTAGE:   480.  ( SEE LOW VOLTAGE REPORT )

HB          VOLTAGE:   480.  ( SEE LOW VOLTAGE REPORT )

HSPS1-BUSA E/Z:      11.981 KA AT  -85.76 DEG ( 86.33 MVA) X/R:      14.38
            SYM*1.6:  19.170 KA      MOMENTARY BASED ON X/R:  18.138 KA
            SYM*2.7:  32.349 KA      CREST BASED ON X/R:   30.562 KA
            VOLTAGE: 4160.  EQUIV. IMPEDANCE= 0.0148 + J 0.1999 OHMS
            CBL-08-P-7  08-P-07 TERM    0.520 KA      ANG:  -263.81
            CBL-08-P-6  08-P-05 TERM    0.520 KA      ANG:  -263.82
            CBL-T8A SEC T8A SEC      10.942 KA      ANG:   94.06

HSPS1-BUSB E/Z:      11.765 KA AT  -85.93 DEG ( 84.77 MVA) X/R:      14.74
            SYM*1.6:  18.824 KA      MOMENTARY BASED ON X/R:  17.865 KA
            SYM*2.7:  31.766 KA      CREST BASED ON X/R:   30.083 KA
            VOLTAGE: 4160.  EQUIV. IMPEDANCE= 0.0145 + J 0.2036 OHMS
            CBL-08-P-3  08-P-02 TERM    0.520 KA      ANG:  -263.82
            CBL-08-P-4  08-P-04 TERM    0.520 KA      ANG:  -263.80
            CBL-T8B SEC T8B SEC      10.726 KA      ANG:  -86.14
    
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T H R E E P H A S E M O M E N T A R Y D U T Y R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

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MCC-1A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC-1B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC-2A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC-2B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC-2C	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC-2D	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC3A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
MCC3B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD 5B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD 7A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD 7B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD STDBY	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-11A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-11B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-5A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-6A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-6B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)

T H R E E P H A S E M O M E N T A R Y D U T Y R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

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UNBALANCED MOMENTARY DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

LOCATION VOLTAGE	FAULT TYPE	E/Z KA	X/R	EQUIVALENT IMPEDANCE (PU)	MOMENTARY E/Z * 1.6	FAULT DUTIES @ 0.5 CYCLE	
=====							
12.47kV BUS-A 12470.	3P Duty: SLG DUTY: VOLTS LN/LN: LN/LN/GND:	6.70 0.40 5.80 5.90 (	15.4 0.1	Z1= Z2= Z0= 0.20	0.6911 0.6911 34.7677 GND RETURN KA)	10.72 0.64	10.23 0.40
12.47kV BUS-B 12470.	3P Duty: SLG DUTY: VOLTS LN/LN: LN/LN/GND:	6.47 0.40 5.60 5.70 (	15.8 0.1	Z1= Z2= Z0= 0.20	0.7157 0.7157 34.7677 GND RETURN KA)	10.35 0.64	9.90 0.40
CNP 138 kV 138000.	3P Duty: SLG DUTY: VOLTS LN/LN: LN/LN/GND:	15.89 10.05 13.76 14.48 (	9.8 6.7	Z1= Z2= Z0= 7.34	0.0263 0.0263 0.0724 GND RETURN KA)	25.43 16.07	22.77 13.42
HSPS1-BUSA 4160.	3P Duty: SLG DUTY: VOLTS LN/LN: LN/LN/GND:	11.98 0.40 10.38 10.48 (	14.4 0.0	Z1= Z2= Z0= 0.20	1.1584 1.1584 104.0498 GND RETURN KA)	19.17 0.64	18.14 0.40
HSPS1-BUSB 4160.	3P Duty: SLG DUTY: VOLTS LN/LN: LN/LN/GND:	11.77 0.40 10.19 10.29 (	14.7 0.0	Z1= Z2= Z0= 0.20	1.1796 1.1796 104.0481 GND RETURN KA)	18.82 0.64	17.87 0.40

M O M E N T A R Y D U T Y S U M M A R Y R E P O R T
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 SOLUTION METHOD : E/Z

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=====
BUS RECORD      VOLTAGE      * 3 P H A S E *      * * * SLG * * *
NO NAME         L-L          KA      X/R          KA      X/R
=====
12.47kV BUS-A   12470.       10.229  15.45         0.398  0.06
12.47kV BUS-B   12470.       9.903   15.79         0.398  0.06
CNP 138 kV      138000.     22.766  9.78          13.419  6.71
HSPS1-BUSA      4160.       18.138  14.38         0.399  0.03
HSPS1-BUSB      4160.       17.865  14.74         0.399  0.03
    
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36 FAULTED BUSES, 119 BRANCHES, 31 CONTRIBUTIONS
 UNBALANCED FAULTS REQUESTED

*** SHORT CIRCUIT STUDY COMPLETE ***

THREE PHASE INTERRUPTING DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

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CONTRIBUTIONS: 08-P-1          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-3          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-2          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-4          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-6          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-7          0.209 KA    ANG:  -84.29
CONTRIBUTIONS: 08-P-8          0.209 KA    ANG:  -84.29
    
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12.47kV BUS-A E/Z:      6.247 KA AT -86.30 DEG ( 134.93 MVA) X/R:  16.08
VOLTAGE: 12470. EQUIV. IMPEDANCE= 0.0745 + J 1.1501 OHMS
CBL-T2A PRI 1  T2A POLE 1      0.058 KA    ANG: -263.75
CBL-T6A PRI    BUS-0125        0.046 KA    ANG: -263.34
CBL-T7A PRI    BUS-0127        0.061 KA    ANG: -252.83
CBL-T8A PRI    BUS-0130        0.137 KA    ANG: -264.13
BD 1           TR1 SEC         5.948 KA    ANG:  93.47
    
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GENERATOR NAME -- AT BUS -- KA  VOLTS PU  LOCAL/REMOTE
CNP              5.941    0.97      R
TOTAL REMOTE:    5.941 KA  NACD RATIO: 0.9510

          SYM2    SYM3    SYM5    SYM8
MULT. FACT: 1.000  1.004  1.010  1.051
DUTY (KA) :  6.247  6.274  6.309  6.568

          TOT2    TOT3    TOT5    TOT8
MULT. FACT: 1.353  1.173  1.078  1.029
DUTY (KA) :  8.450  7.330  6.731  6.429
    
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12.47kV BUS-B E/Z:      6.144 KA AT -86.41 DEG ( 132.69 MVA) X/R:  16.25
VOLTAGE: 12470. EQUIV. IMPEDANCE= 0.0733 + J 1.1696 OHMS
CBL-T2B PRI 1  T2B POLE 1      0.028 KA    ANG: -263.92
CBL-T6B PRI    BUS-0126        0.011 KA    ANG: -263.03
CBL-T7B PRI    BUS-0129        0.021 KA    ANG: -252.64
CBL-T8B PRI    BUS-0131        0.137 KA    ANG: -264.13
BD 2           TR2 SEC         5.948 KA    ANG:  93.47
    
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GENERATOR NAME -- AT BUS -- KA  VOLTS PU  LOCAL/REMOTE
CNP              5.938    0.97      R
TOTAL REMOTE:    5.938 KA  NACD RATIO: 0.9665

          SYM2    SYM3    SYM5    SYM8
MULT. FACT: 1.000  1.006  1.012  1.054
DUTY (KA) :  6.144  6.183  6.215  6.474
    
```

THREE PHASE INTERRUPTING DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 NACD OPTION: INTERPOLATED

=====

	TOT2	TOT3	TOT5	TOT8
MULT. FACT:	1.356	1.177	1.080	1.031
DUTY (KA) :	8.328	7.229	6.638	6.335

CNP 138 kV E/Z: 15.832 KA AT -84.16 DEG (3784.27 MVA) X/R: 9.78
 VOLTAGE: 138000. EQUIV. IMPEDANCE= 0.5119 + J 5.0063 OHMS
 CONTRIBUTIONS: CNP 15.789 KA ANG: -84.17
 T1 TR1 SEC 0.026 KA ANG: -81.88
 T2 TR2 SEC 0.017 KA ANG: -82.94

GENERATOR NAME -- AT BUS -- KA VOLTS PU LOCAL/REMOTE
 CNP 15.789 0.00 R
 TOTAL REMOTE: 15.789 KA NACD RATIO: 0.9973

	SYM2	SYM3	SYM5	SYM8
MULT. FACT:	1.000	1.000	1.000	1.004
DUTY (KA) :	15.832	15.832	15.832	15.890

	TOT2	TOT3	TOT5	TOT8
MULT. FACT:	1.203	1.051	1.006	1.000
DUTY (KA) :	19.051	16.634	15.926	15.832

HA VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)

HB VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)

HSPS1-BUSA E/Z: 11.103 KA AT -86.06 DEG (80.00 MVA) X/R: 14.92
 VOLTAGE: 4160. EQUIV. IMPEDANCE= 0.0148 + J 0.2158 OHMS
 CBL-08-P-7 08-P-07 TERM 0.209 KA ANG: -264.10
 CBL-08-P-6 08-P-05 TERM 0.209 KA ANG: -264.10
 CBL-T8A SEC T8A SEC 10.685 KA ANG: 93.86

GENERATOR NAME -- AT BUS -- KA VOLTS PU LOCAL/REMOTE
 CNP 10.390 0.98 R
 TOTAL REMOTE: 10.390 KA NACD RATIO: 0.9358

	SYM2	SYM3	SYM5	SYM8
MULT. FACT:	1.000	1.000	1.000	1.040
DUTY (KA) :	11.103	11.103	11.103	11.543

THREE PHASE INTERRUPTING DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 NACD OPTION: INTERPOLATED

```
=====
                TOT2   TOT3   TOT5   TOT8
MULT. FACT:    1.332   1.153   1.063   1.018
DUTY (KA) :    14.793  12.804  11.797  11.306

HSPS1-BUSB    E/Z:      11.010 KA AT -86.18 DEG ( 79.33 MVA) X/R: 15.20
VOLTAGE:      4160.    EQUIV. IMPEDANCE= 0.0145 + J 0.2177 OHMS
CBL-08-P-3    08-P-02 TERM      0.209 KA    ANG: -264.10
CBL-08-P-4    08-P-04 TERM      0.209 KA    ANG: -264.09
CBL-T8B SEC   T8B SEC           10.593 KA    ANG: -86.26
```

```
GENERATOR NAME -- AT BUS -- KA    VOLTS PU  LOCAL/REMOTE
CNP              10.472    0.98      R
TOTAL REMOTE:    10.472 KA  NACD RATIO: 0.9511
```

```
                SYM2   SYM3   SYM5   SYM8
MULT. FACT:    1.000   1.000   1.002   1.043
DUTY (KA) :    11.010  11.010  11.030  11.481
```

```
                TOT2   TOT3   TOT5   TOT8
MULT. FACT:    1.338   1.159   1.067   1.021
DUTY (KA) :    14.730  12.757  11.745  11.242
```

- MCC-1A VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC-1B VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC-2A VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC-2B VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC-2C VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC-2D VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC3A VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- MCC3B VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)
- SWBD 5B VOLTAGE: 480. (SEE LOW VOLTAGE REPORT)

T H R E E P H A S E I N T E R R U P T I N G D U T Y R E P O R T
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

=====

SWBD 7A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD 7B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD STDBY	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-11A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-11B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-5A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-6A	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)
SWBD-6B	VOLTAGE:	480.	(SEE LOW VOLTAGE REPORT)

UNBALANCED INTERRUPTING DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 NACD OPTION: INTERPOLATED

LOCATION	FAULT TYPE	E/Z KA	X/R	ANSI DECREMENT 3 PHASE	AC/DC FACT. SLG	INTERRUPTING DUTIES 3 PHASE	(KA) SLG
12.47kV BUS-A	3P Duty:	6.25	16.1	SYM2:	1.00	1.00	6.25 0.40
VOLTS: 12470.0	SLG:	0.40	0.1	SYM3:	1.00	1.00	6.27 0.40
NACD: 0.951	LN/LN:	5.41		SYM5:	1.01	1.00	6.31 0.40
	LN/LN/GND:	5.51		SYM8:	1.05	1.00	6.57 0.40
	GND RETURN:	0.20		TOT2:	1.35	1.00	8.45 0.40
	Z1(PU):		0.74115	TOT3:	1.17	1.00	7.33 0.40
	Z2(PU):		0.74115	TOT5:	1.08	1.00	6.73 0.40
	Z0(PU):		34.76768	TOT8:	1.03	1.00	6.43 0.40
12.47kV BUS-B	3P Duty:	6.14	16.2	SYM2:	1.00	1.00	6.14 0.40
VOLTS: 12470.0	SLG:	0.40	0.1	SYM3:	1.01	1.00	6.18 0.40
NACD: 0.967	LN/LN:	5.32		SYM5:	1.01	1.00	6.21 0.40
	LN/LN/GND:	5.42		SYM8:	1.05	1.00	6.47 0.40
	GND RETURN:	0.20		TOT2:	1.36	1.00	8.33 0.40
	Z1(PU):		0.75362	TOT3:	1.18	1.00	7.23 0.40
	Z2(PU):		0.75362	TOT5:	1.08	1.00	6.64 0.40
	Z0(PU):		34.76768	TOT8:	1.03	1.00	6.33 0.40
CNP 138 kV	3P Duty:	15.83	9.8	SYM2:	1.00	1.00	15.83 10.03
VOLTS: 138000.0	SLG:	10.03	6.7	SYM3:	1.00	1.00	15.83 10.03
NACD: 0.997	LN/LN:	13.71		SYM5:	1.00	1.00	15.83 10.03
	LN/LN/GND:	14.43		SYM8:	1.00	1.00	15.89 10.03
	GND RETURN:	7.34		TOT2:	1.20	1.11	19.05 11.10
	Z1(PU):		0.02643	TOT3:	1.05	1.00	16.63 10.06
	Z2(PU):		0.02643	TOT5:	1.01	1.00	15.93 10.03
	Z0(PU):		0.07238	TOT8:	1.00	1.00	15.83 10.03
HSPS1-BUSA	3P Duty:	11.10	14.9	SYM2:	1.00	1.00	11.10 0.40
VOLTS: 4160.0	SLG:	0.40	0.0	SYM3:	1.00	1.00	11.10 0.40
NACD: 0.936	LN/LN:	9.62		SYM5:	1.00	1.00	11.10 0.40
	LN/LN/GND:	9.71		SYM8:	1.04	1.00	11.54 0.40
	GND RETURN:	0.20		TOT2:	1.33	1.00	14.79 0.40
	Z1(PU):		1.25004	TOT3:	1.15	1.00	12.80 0.40
	Z2(PU):		1.25004	TOT5:	1.06	1.00	11.80 0.40
	Z0(PU):		104.04986	TOT8:	1.02	1.00	11.31 0.40

UNBALANCED INTERRUPTING DUTY REPORT
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 NACD OPTION: INTERPOLATED

LOCATION	FAULT TYPE	E/Z KA	X/R	ANSI AC/DC DECREMENT FACT.		INTERRUPTING DUTIES (KA)	
				3 PHASE	SLG	3 PHASE	SLG
HSPS1-BUSB	3P Duty:	11.01	15.2	SYM2:	1.00	1.00	11.01 0.40
VOLTS: 4160.0	SLG:	0.40	0.0	SYM3:	1.00	1.00	11.01 0.40
NACD: 0.951	LN/LN:	9.54		SYM5:	1.00	1.00	11.03 0.40
	LN/LN/GND:	9.63		SYM8:	1.04	1.00	11.48 0.40
	GND RETURN:	0.20		TOT2:	1.34	1.00	14.73 0.40
	Z1(PU):	1.26053		TOT3:	1.16	1.00	12.76 0.40
	Z2(PU):	1.26053		TOT5:	1.07	1.00	11.75 0.40
	Z0(PU):	104.04815		TOT8:	1.02	1.00	11.24 0.40

I N T E R R U P T I N G D U T Y S U M M A R Y R E P O R T

PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO
 NACD OPTION: INTERPOLATED

BUS RECORD NO NAME	VOLTAGE L-L	NACD RATIO	* 3 P H A S E * E/Z KA	X/R	* * * S L G * * * E/Z KA	X/R
12.47kV BUS-A	12470.	0.951	6.247	16.08	0.398	0.06
12.47kV BUS-B	12470.	0.967	6.144	16.25	0.398	0.06
CNP 138 kV	138000.	0.997	15.832	9.78	10.030	6.71
HSPS1-BUSA	4160.	0.936	11.103	14.92	0.399	0.03
HSPS1-BUSB	4160.	0.951	11.010	15.20	0.399	0.03

36 FAULTED BUSES, 119 BRANCHES, 31 CONTRIBUTIONS
 UNBALANCED FAULTS REQUESTED

*** SHORT CIRCUIT STUDY COMPLETE ***

Section 4

Protective Device Coordination Study

4.1 Purpose of Coordination Study

The purpose of the coordination study is to derive protective device settings such that protection and selectivity are optimized. Time Current Coordination (TCC) curves were plotted on a log-log scale as operating time versus current magnitude to show protective device tripping characteristics and coordination among devices. TCC curves are included for the main circuit breaker and the largest downstream circuit breakers. It is understood that if the main circuit breaker coordinates with the largest downstream circuit breakers, then all smaller downstream circuit breakers will coordinate with the main circuit breaker.

4.2 Coordination Study Results

Coordination was performed for all circuit breakers equipped with adjustable trip units using the fault current (short circuit current) values obtained from the Short Circuit Study. The TCC curves are computer generated and a one-line diagram is included for each curve as an aid in evaluating the settings. TCC curves also include settings for each device shown on the respective TCC curves. A tabulation for each device and the device settings are indicated on the curves. In developing the device settings, consideration was given to both isolation of faults and protection of cables and transformers. Minimum requirements for equipment protection were followed as outlined in the National Electric Code (NEC) and applicable standards of the American National Standards Institute (ANSI) and the Institute of Electrical and Electronic Engineers (IEEE).

4.3 Coordination Study Recommendations

- a. Recommended protective relay and circuit breaker settings are located in Section 5 of this report. The recommended settings provide improved protection of equipment and/or improved coordination between devices that are in series. The recommended settings should be implemented at the first opportunity.
- b. The size of the current transformer (CT) in the neutral grounding resistor of unit substation Transformers T8A and T8B is uncertain. Record drawings do not indicate neutral grounding resistor CT size. The EPE July 2003 Power System Study indicated a CT size of 400/5. Due to the neutral grounding resistor location on top of the unit substation transformers it is difficult to access the neutral grounding resistor CTs. When Transformers T8A and T8B are relocated for service to a new electrical building for new ASDs, the existing CTs can be replaced with 400/5 CTs. A CT ratio of 400/5 has been used for the neutral grounding resistor for T8A and T8B in this report.
- c. Record drawings and field observations indicate ANSI Devices 67 and 67N (directional overcurrent relays) are included on the 12.47 kV Main Circuit Breakers in Switchgear "SWGR-S". It is our understanding that when operating on power from CenterPoint Energy, it is the City's operating philosophy to never close the 12.47 kV tie circuit breaker unless Main Circuit Breaker "MA" or "MB" is open. We also understand there is interlock wiring to prevent "MA", "MB" and the 12.47 kV tie circuit breaker from being closed at the

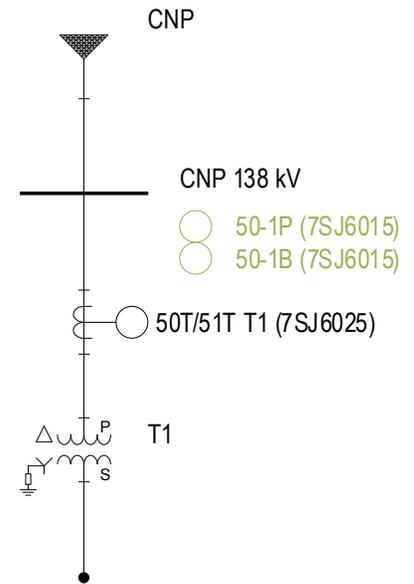
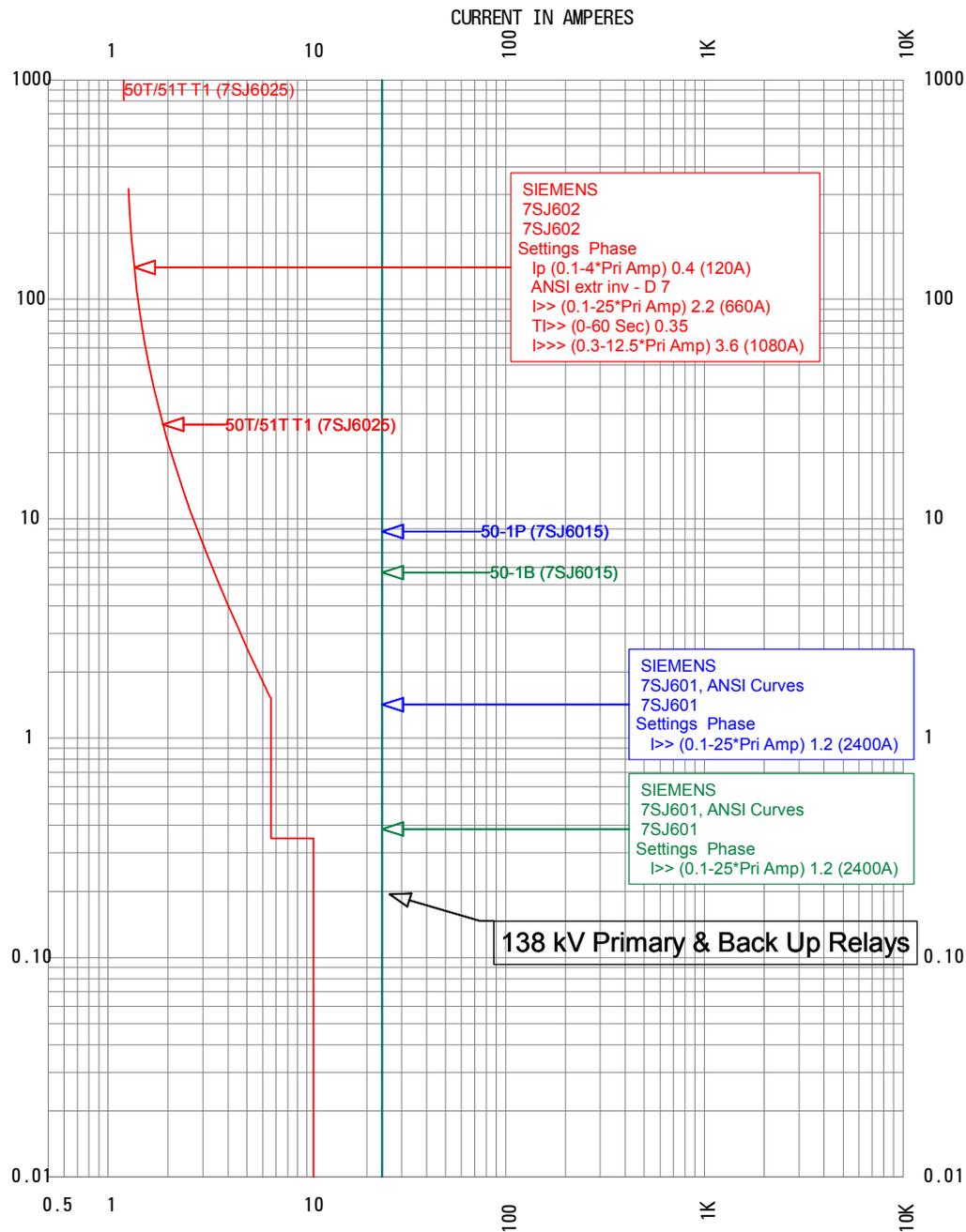
same time. We have not observed testing to prove interlock wiring is functional. Based on the above described operating philosophy, Devices 67 and 67N are not needed to detect power flow from the NEWPP to CenterPoint Energy. At the City's option, Devices 67 and 67N can be left in service in the event the City changes operating philosophy.

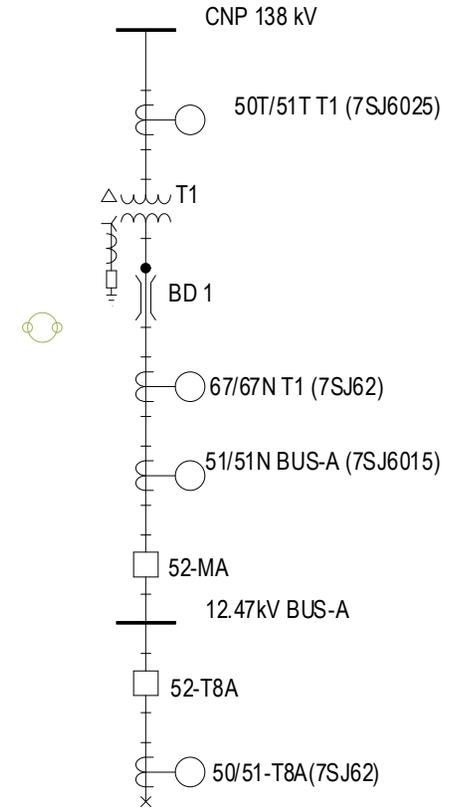
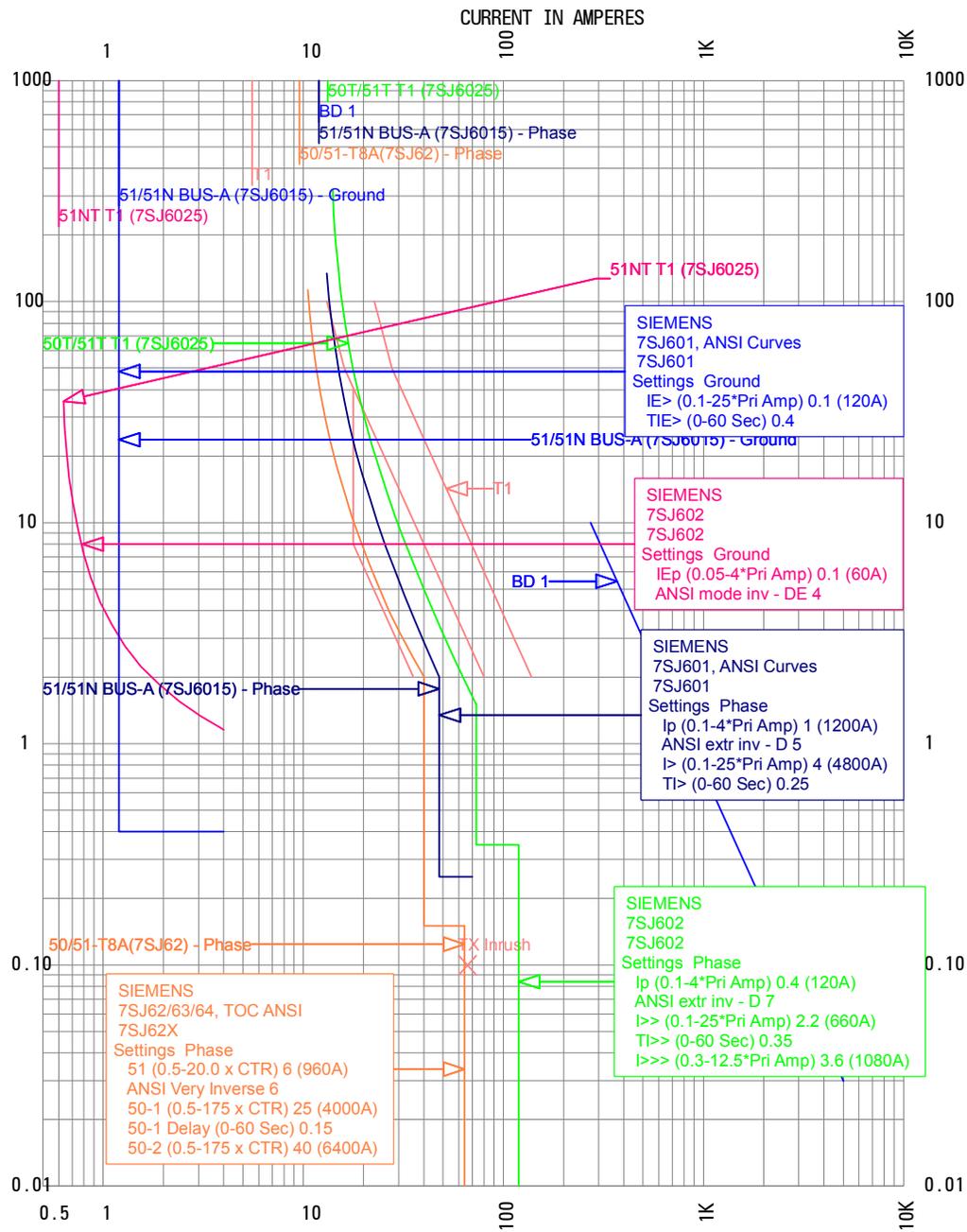
- d. Unit substation Transformer T8A and T8B have 720E rated fuses. These fuses will be removed when the transformer are relocated to the new electrical building for high service pump ASDs. The 720E rated fuses are not included in the studies in this report. Transformers T8A and T8B will be protected by Siemens 7SJ62 relays in the "SWGR-S" Switchgear.
- e. NRG standby generators connect to 12.47 kV Feeder T2A. Documentation is not available from NRG to understand modifications to the original Siemens 7SJ62 relay or the addition of a Schweitzer SEL-751A relay to the T2A Feeder. The existing 7SJ62 relay settings protect Transformer T2A, however, overall coordination is poor. One example of poor coordination is the ground fault for T2A is set to pickup at 300 amps whereas upstream relays are set at 70 and 120 amps. This issue to be further investigated when information is available from NRG.
- f. All protective devices shall be tested and set in accordance with Section 5 of this report.

4.4 Time Current Coordination Curves

Time Current Coordination curves listed below follow this page.

- TCC: 138 kV Relays
- TCC: T1
- TCC: T8A
- TCC: 08-P-6
- TCC: T2A
- TCC: T2B
- TCC: 02-P-03
- TCC: SWBD6A
- TCC: SWBD6A_GND
- TCC: 05-P-03
- TCC: SWBD7A
- TCC: SWBD7A_GND



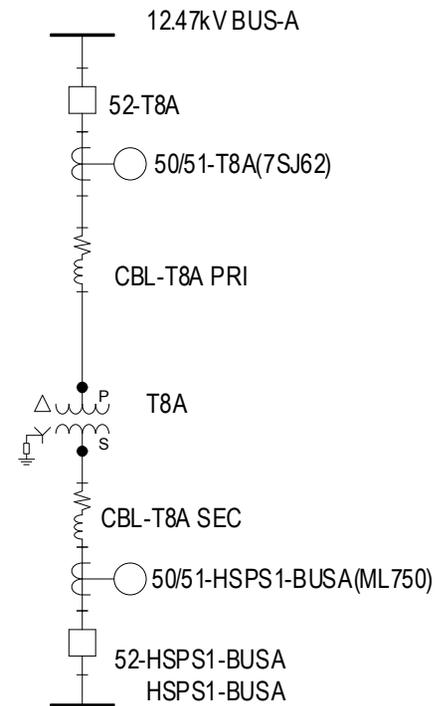
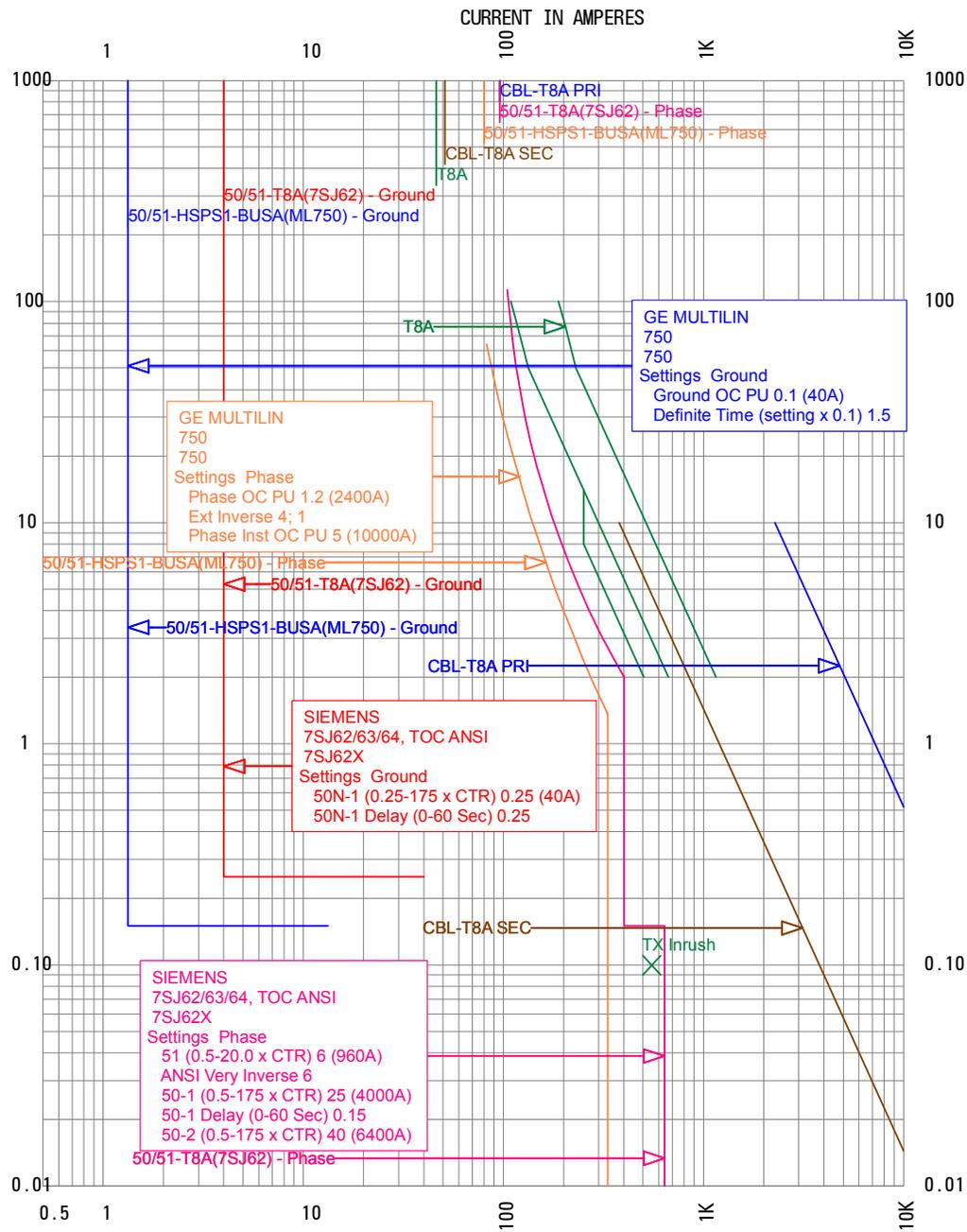


TCC: T1

Current Scale x 100

Reference Voltage: 12470

March 23, 2014

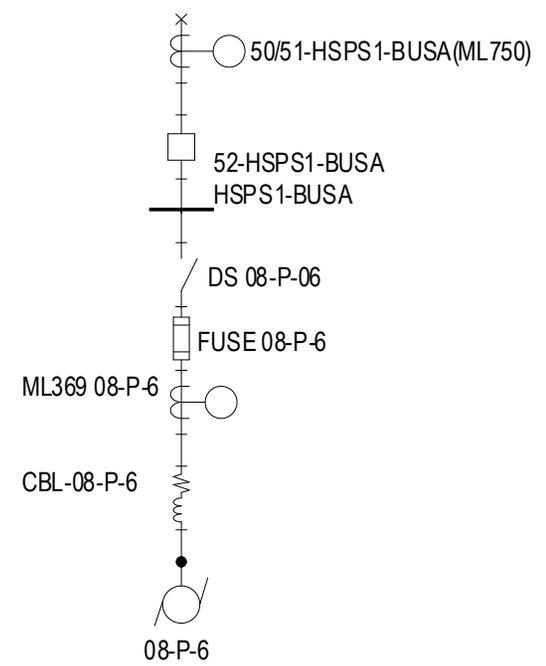
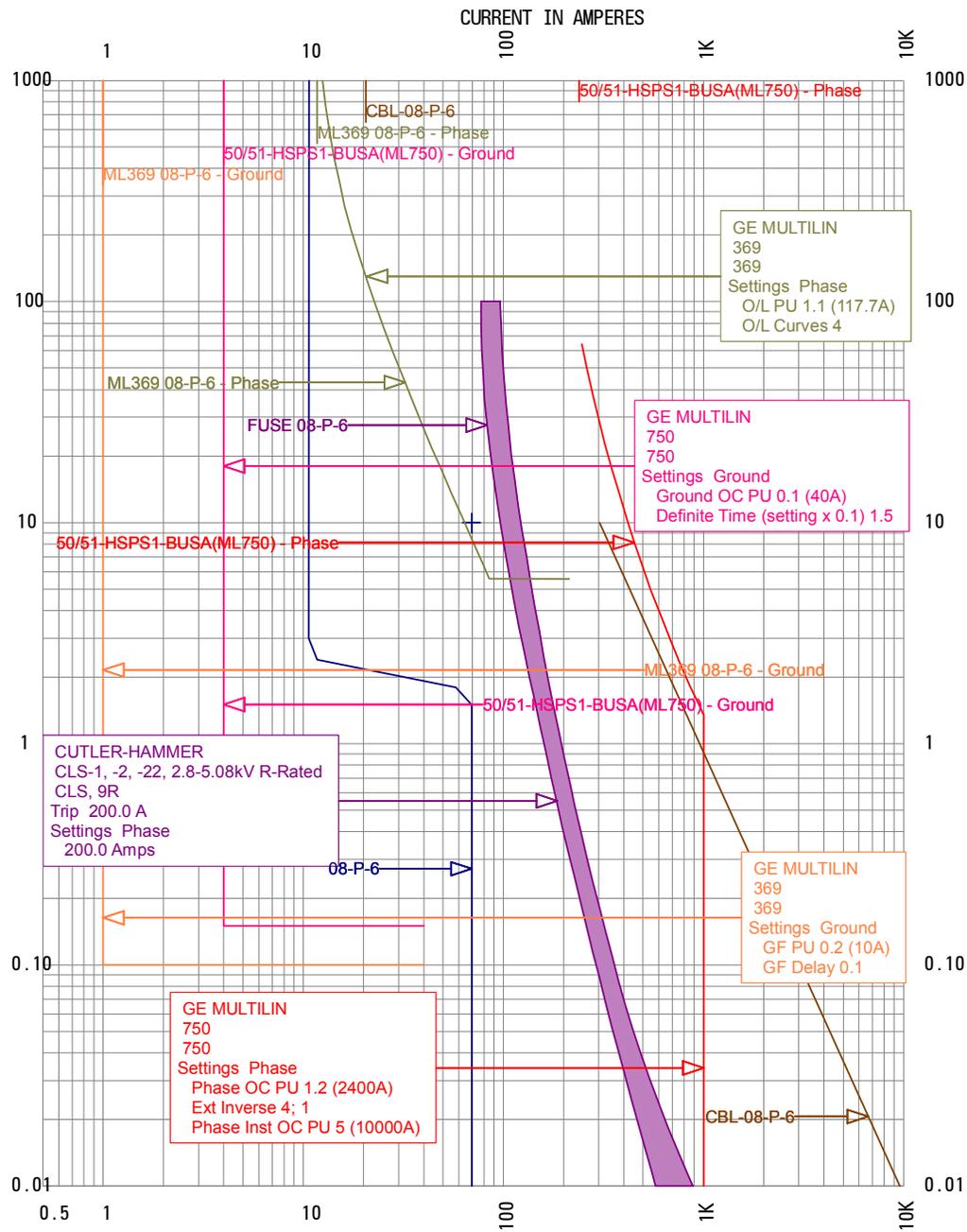


TCC: T8A

Current Scale x 10

Reference Voltage: 12470

March 23, 2014

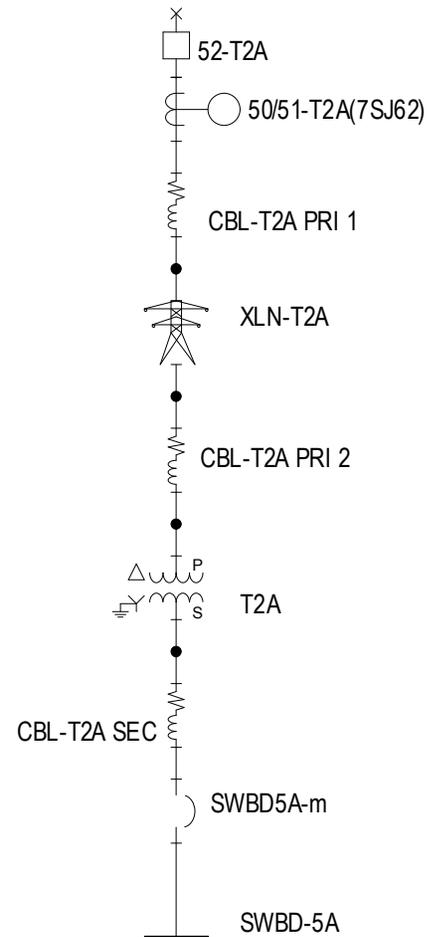
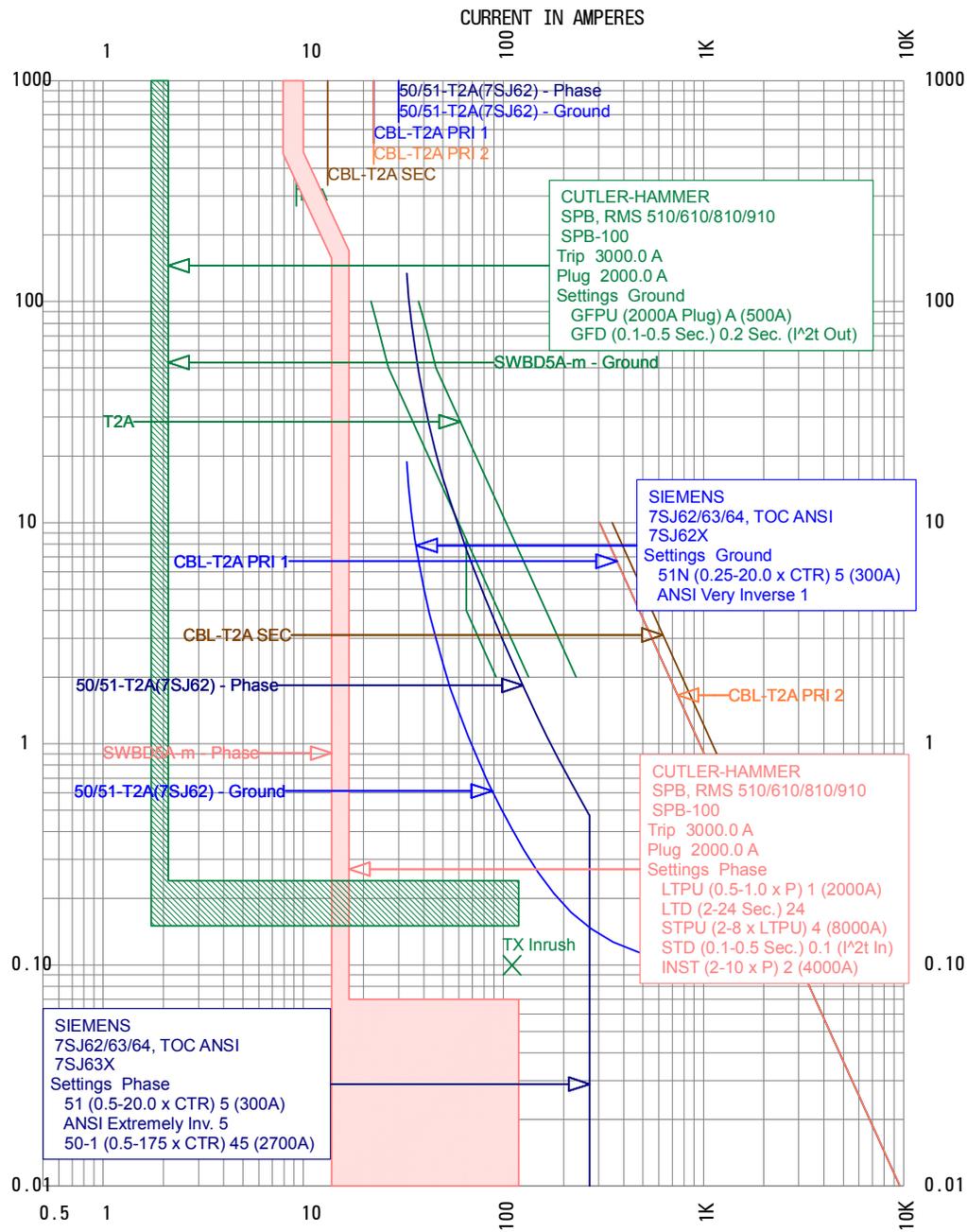


TCC: 08-P-6

Current Scale x 10

Reference Voltage: 4160

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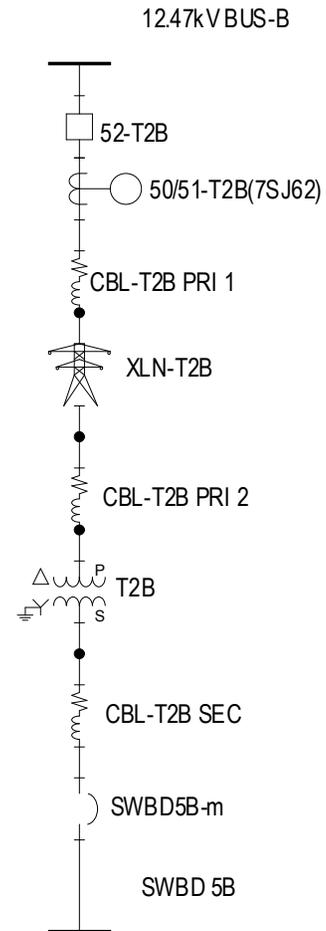
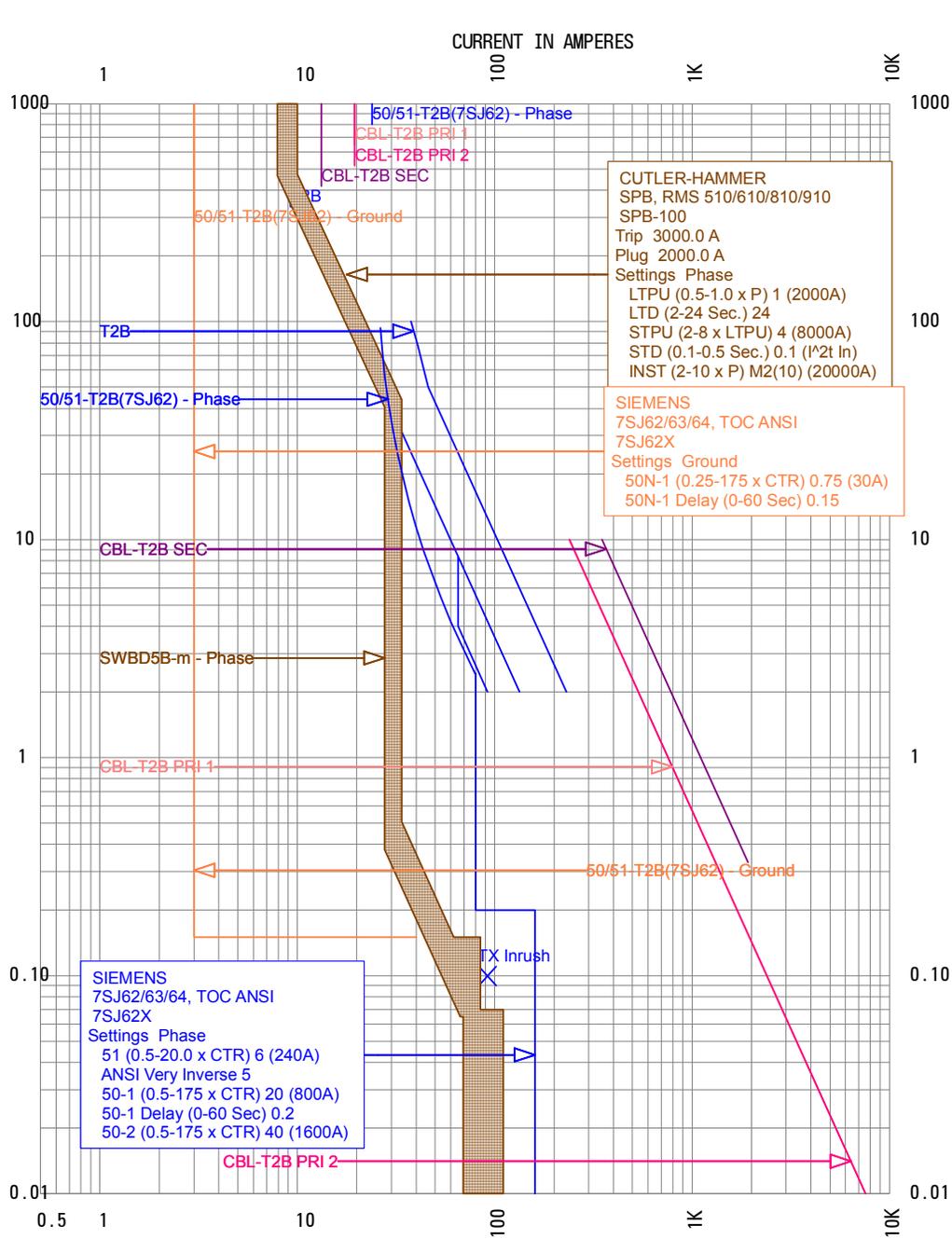


TCC: T2A

Current Scale x 10

Reference Voltage: 12470

March 23, 2014

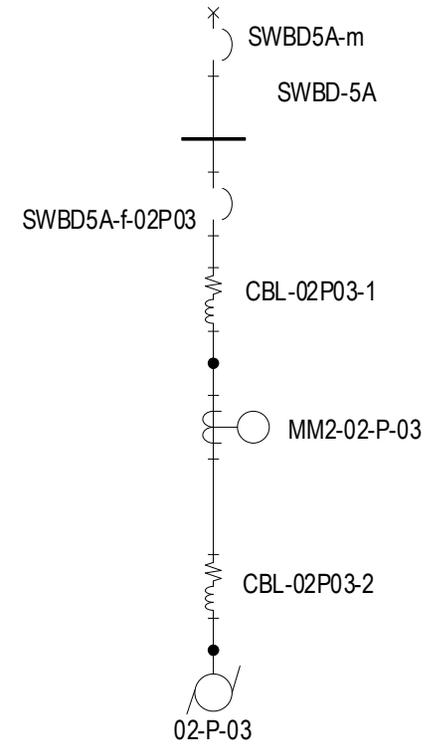
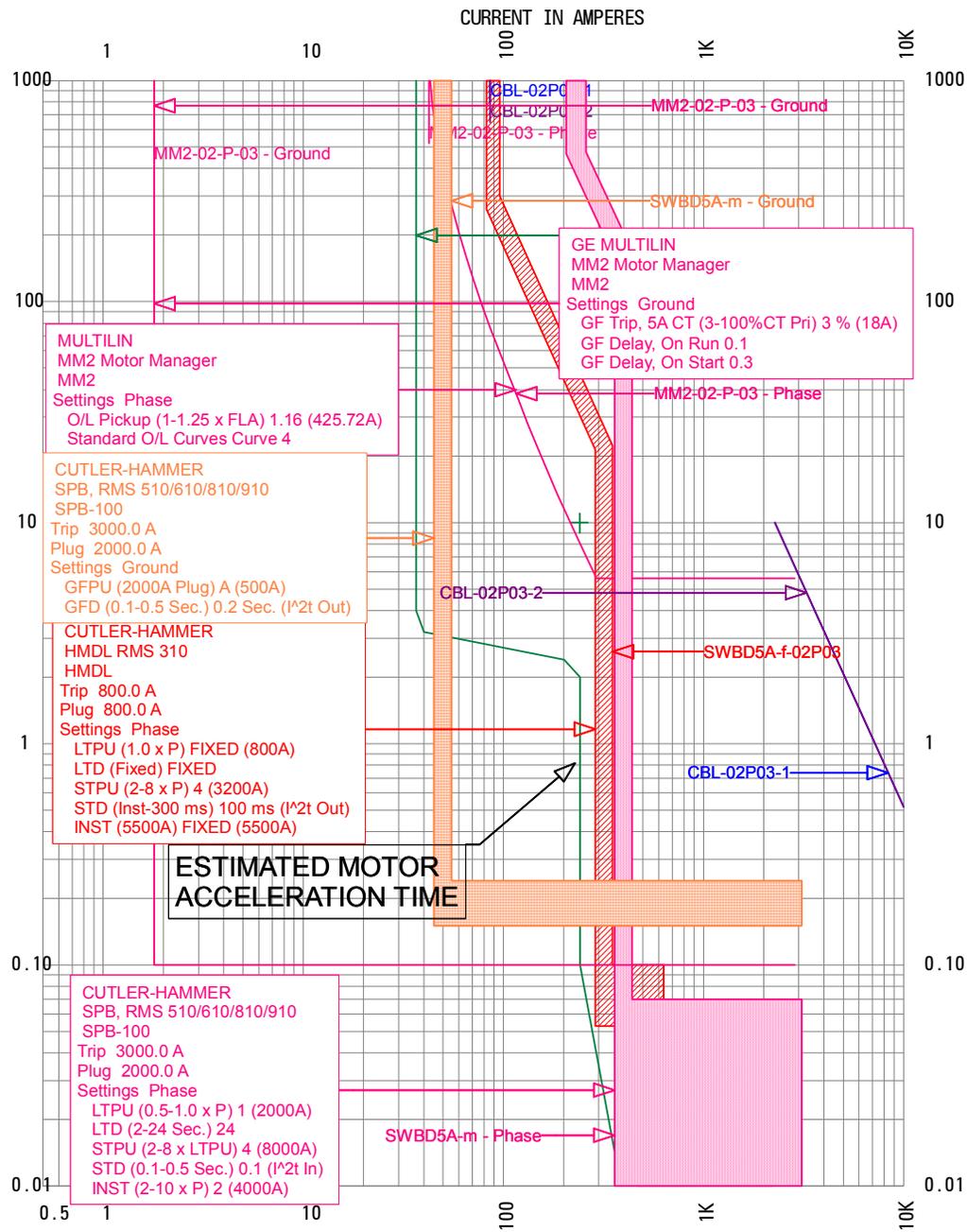


TCC: T2B

Current Scale x 10

Reference Voltage: 12470

March 23, 2014

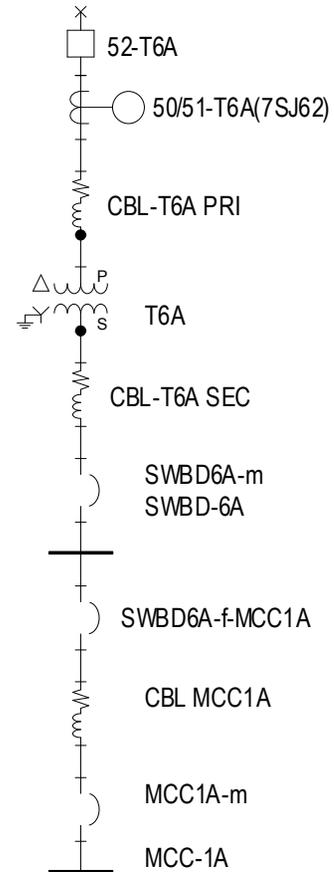
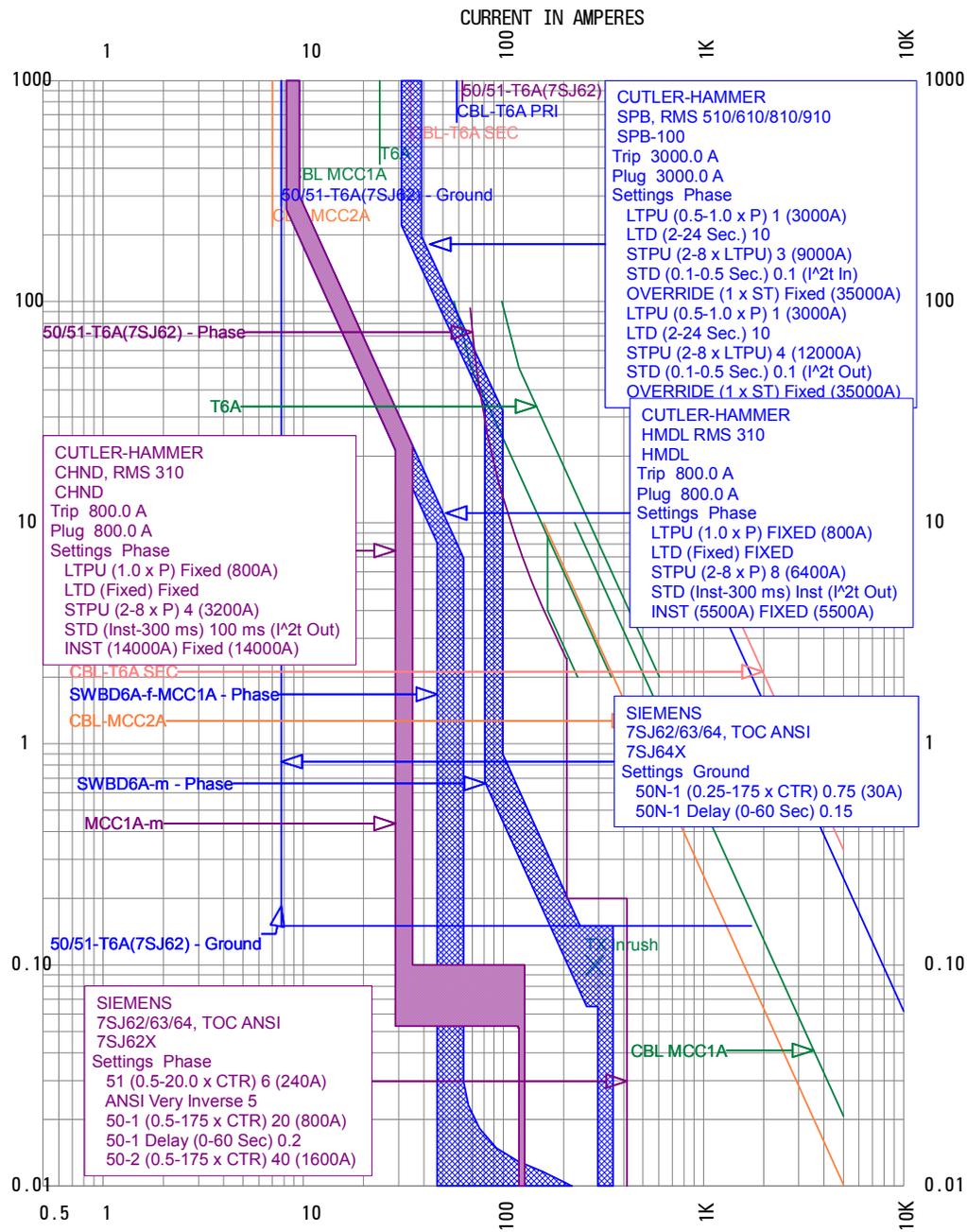


TCC: 02-P-03

Current Scale x 10

Reference Voltage: 480

March 23, 2014

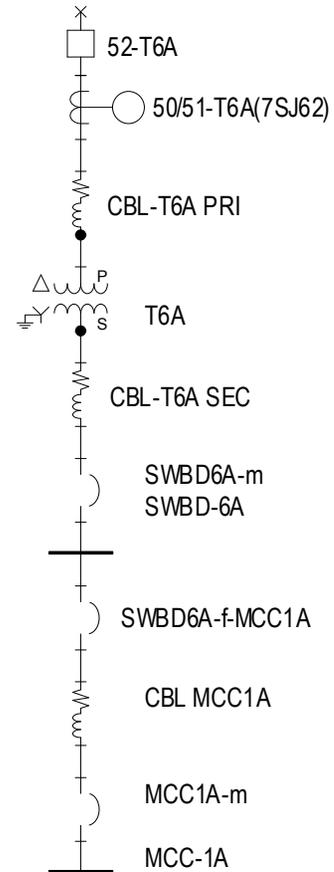
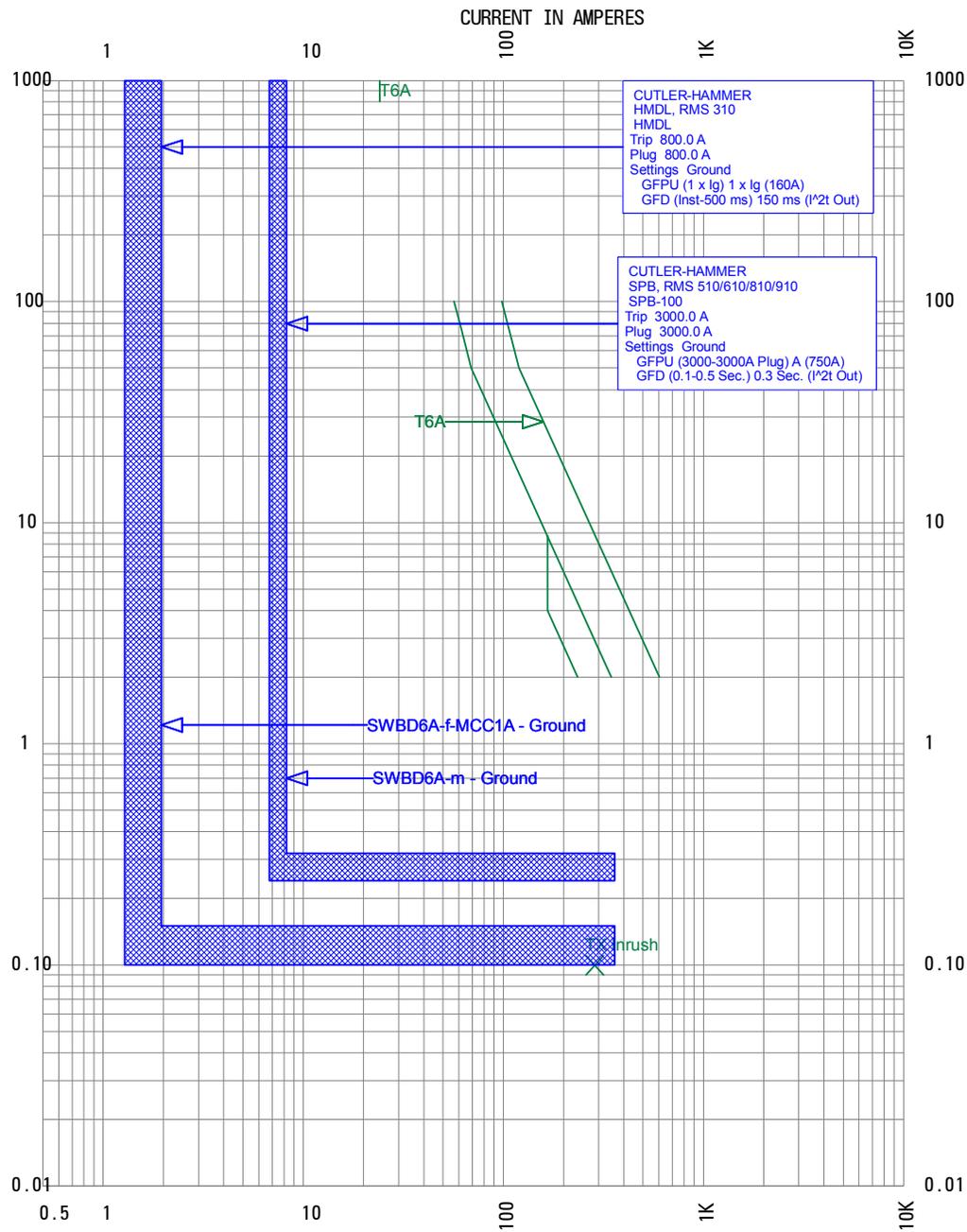


TCC: SWBD6A

Current Scale x 100

Reference Voltage: 480

March 23, 2014

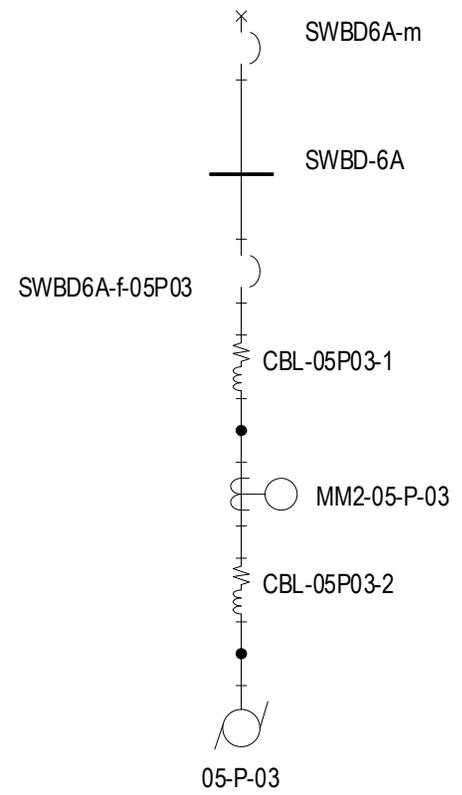
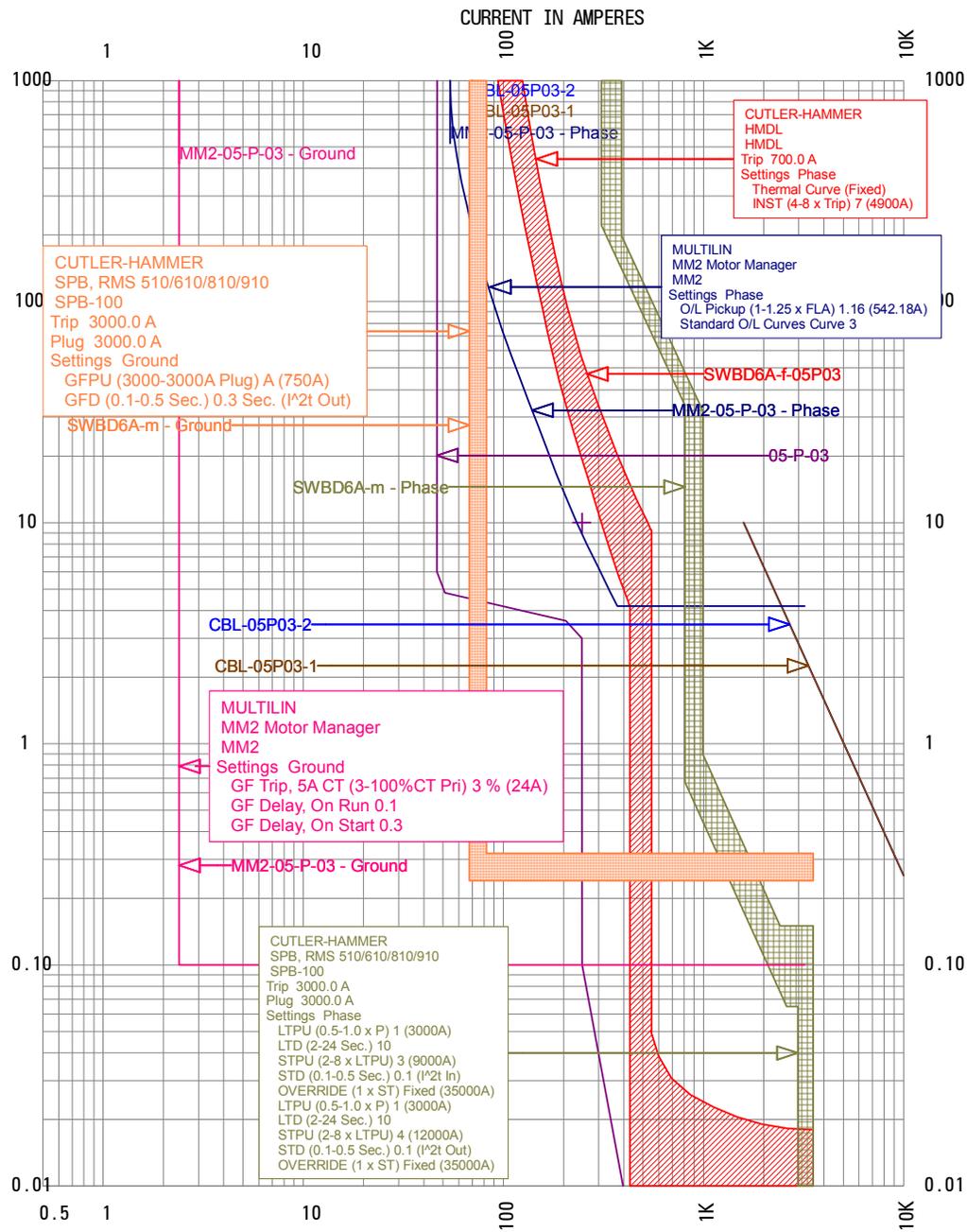


TCC: SWBD6A_GND

Current Scale x 100

Reference Voltage: 480

March 23, 2014

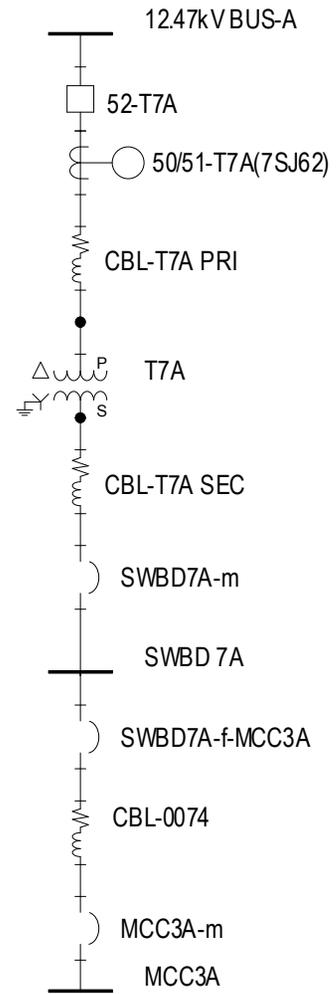
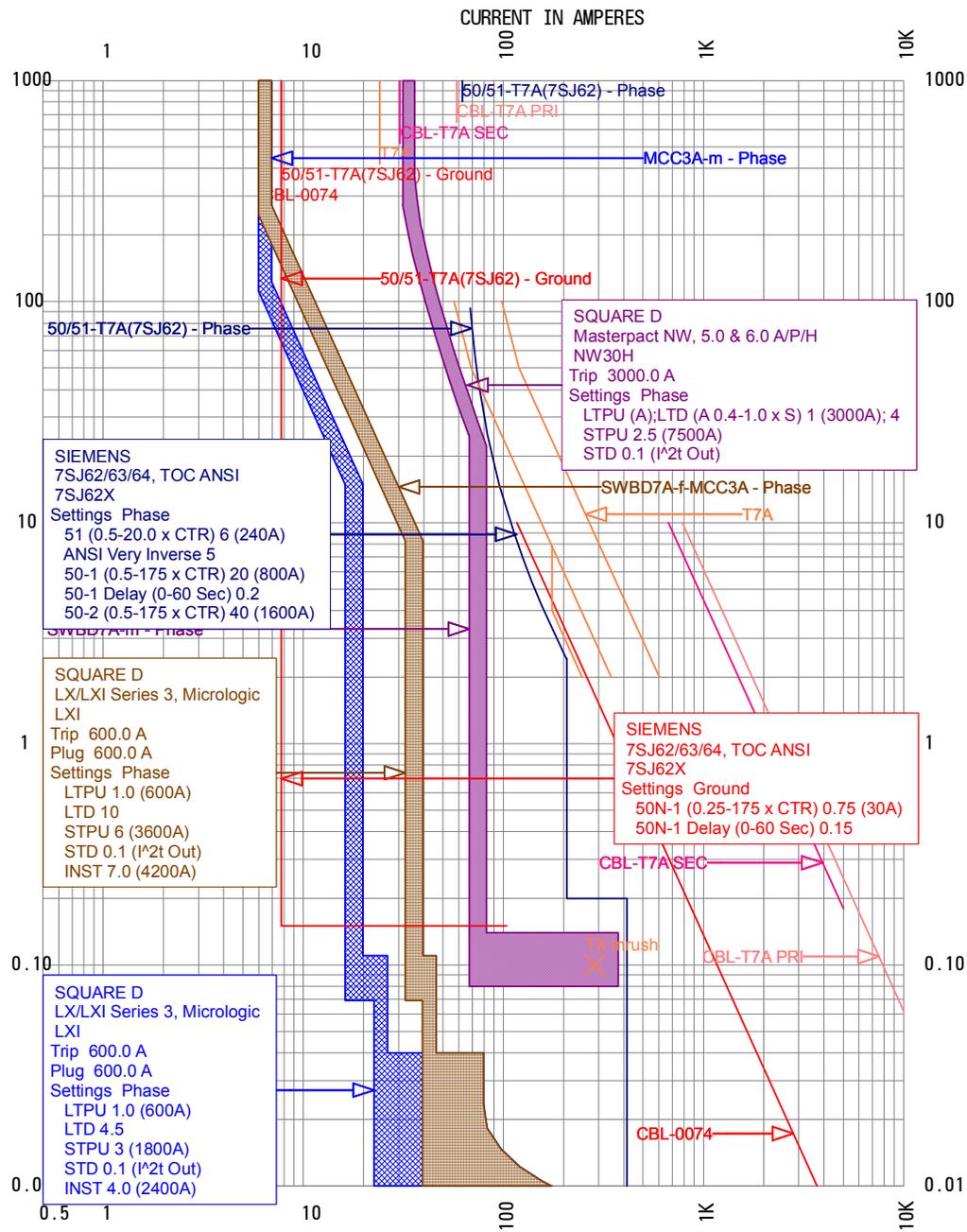


TCC: 05-P-03

Current Scale x 10

Reference Voltage: 480

March 23, 2014

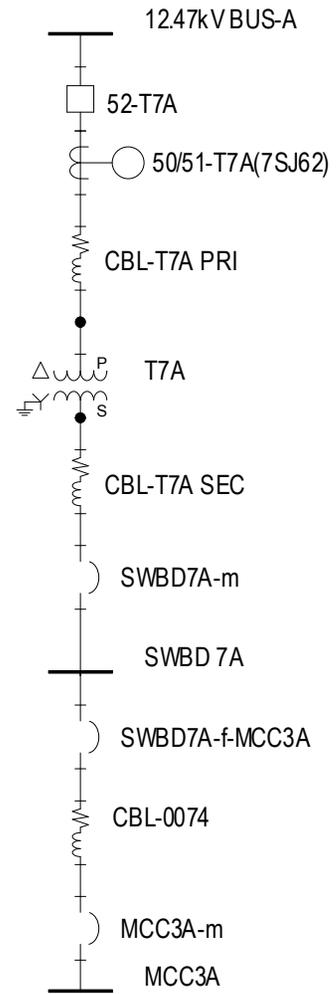
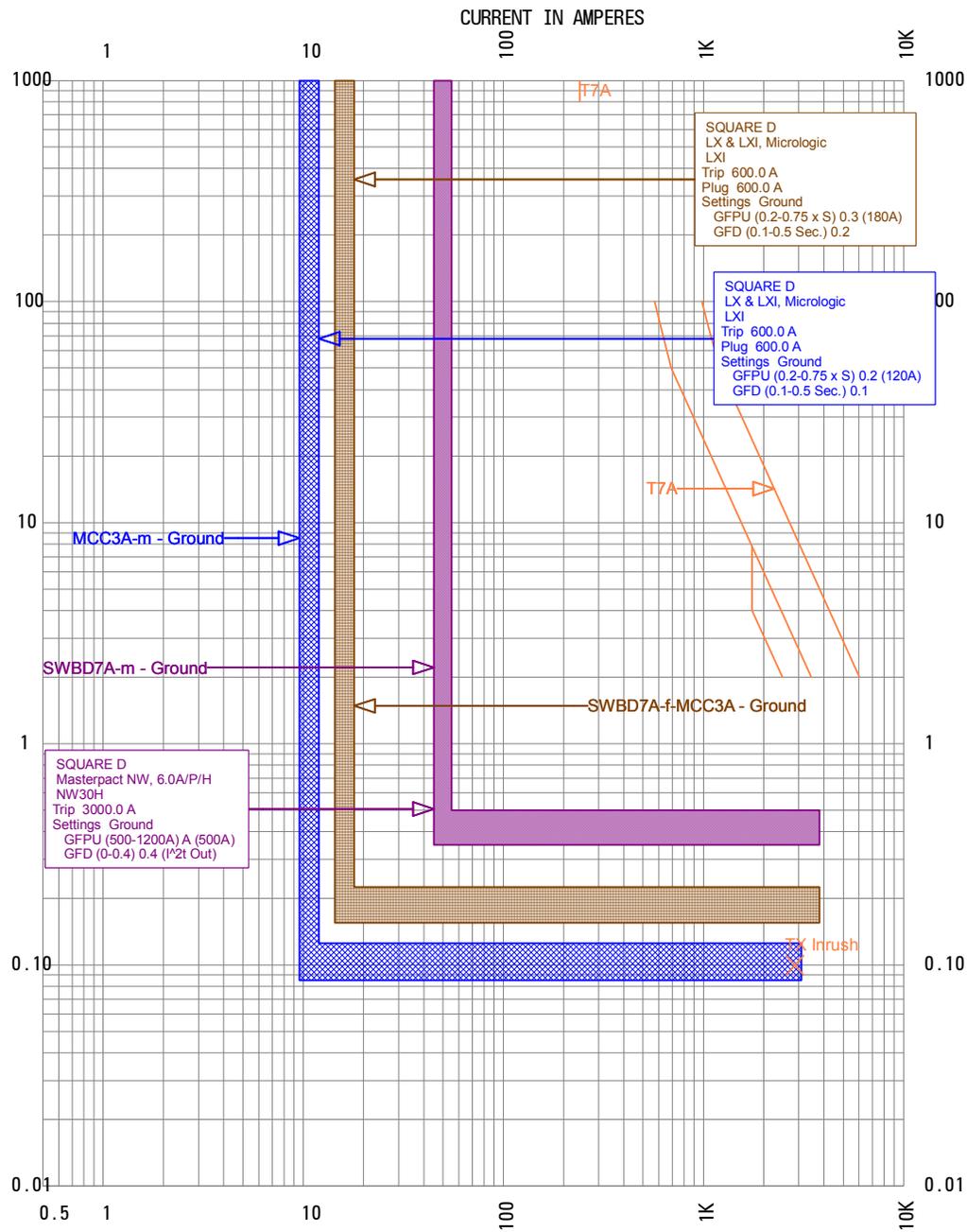


TCC: SWBD7A

Current Scale x 100

Reference Voltage: 480

March 23, 2014



TCC: SWBD7A_GND

Current Scale x 10

Reference Voltage: 480

March 23, 2014

Section 5

Protective Device Settings Record

Protective device settings records follow this page.

- 5.1 Settings Record - Siemens 7SJ601 Relays
- 5.2 Settings Record - Siemens 7SJ602 Relays
- 5.3 Settings Record - Siemens 7SJ62 Relays
- 5.4 Settings Record - Multilin 750 Feeder Protection Relays
- 5.5 Settings Record - Multilin 369 Motor Protection Relays
- 5.6 Settings Record - Multilin MM2 Motor Protection Relays
- 5.7 Settings Record - Siemens 7UT612 Transformer Differential Relays
- 5.8 Settings Record - Switchboard 5 Circuit Breakers
- 5.9 Settings Record - Switchboard 6 Circuit Breakers
- 5.10 Settings Record - Switchboard 7 Circuit Breakers

5.1 RELAY SETTING RECORD (SIEMENS 7SJ601)

Date 20-Mar-14

RELAY		RELAY DESCRIPTION			CT Ratio	PHASE SETTINGS						GROUND SETTINGS						COMMENTS AND ADDITIONAL SETTINGS	
Device ID	Location Bus Name	Mfg.	Model Number	Long Time			Short Time		Instantaneous		Long Time			Short Time		Instantaneous			
				PU Ip		Curve Type	Time Dial	PU I>	Delay T	PU I>>	Delay T	PU lep	Curve Type	Time Dial	PU le>	Delay T	PU le>>		Delay T
51/51N BUS A	12.47kV BUS A	Siemens	7SJ601	PH 1200:5 GD 1200:5	1	ANSI/ V. Inv.	5	-	-	-	-	0.09	ANSI/ Ex. Inv.	3.2	-	-	-	-	Existing Settings
51/51N BUS A	12.47kV BUS A	Siemens	7SJ601	PH 1200:5 GD 1200:5	1	ANSI/ Ex. Inv.	5	4	0.25	-	-	-	-	-	0.1	0.4	-	-	Recommended Settings
51/51N BUS B	12.47kV BUS B	Siemens	7SJ601	PH 1200:5 GD 1200:5	1	ANSI/ Very Inv.	5	-	-	-	-	0.09	ANSI/ Ex. Inv.	3.2	-	-	-	-	Existing Settings
51/51N BUS B	12.47kV BUS B	Siemens	7SJ601	PH 1200:5 GD 1200:5	1	ANSI/ Ex. Inv.	5	4	0.25	-	-	-	-	-	0.1	0.4	-	-	Recommended Settings
50-1P	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Existing Settings
50-1P	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Recommended Settings
50-1B	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Existing Settings
50-1B	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Recommended Settings
50-2P	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Existing Settings
50-2P	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Recommended Settings
50-2B	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Existing Settings
50-2B	138kV BUS	Siemens	7SJ601	PH 2000:5	-	-	-	-	-	1.2	0	-	-	.	-	-	-	-	Recommended Settings

5.2 RELAY SETTING RECORD (SIEMENS 7SJ602)

Date: 20-Mar-14

RELAY		RELAY DESCRIPTION		CT Ratio	PHASE SETTINGS						GROUND SETTINGS						COMMENTS AND ADDITIONAL SETTINGS		
Device ID	Location Bus Name	Mfg.	Model Number		Long Time			Short Time		Instantaneous		Long Time			Short Time			Instantaneous	
					PU I>	Curve Type	Time Dial	PU I>>	Delay T>>	PU I>>>	Delay T>>>	PU Ie>	Curve Type	Time Dial	PU Ie>>	Delay T>>		PU Ie>>>	Delay T>>>
50T/51T T1 51NT T1	CNP 138 kV T1 Neutral	Siemens Siemens	7SJ602 7SJ602	PH 300:5 GD 600:5	0.4 -	ANSI/ Ex. Inv -	5.8 -	3.1 -	0,0 -	- -	- -	0.2	ANSI/Ex. Inv	3.4	-	-	- -	- -	Existing Settings
50T/51T T1 51NT-T1	CNP 138 kV T1 Neutral	Siemens Siemens	7SJ602 7SJ602	PH 300:5 GD 600:5	0.4 -	ANSI/ Ex. Inv -	7 -	2.2 -	0.35 -	3.6 -	0 -	- 0.1	- ANSI/Mod. Inv	- 4	- -	- -	- -	- -	Recommended Settings
50T/51T T2 51NT T2	CNP 138 kV T1 Neutral	Siemens Siemens	7SJ602 7SJ602	PH 300:5 GD 600:5	0.4 -	ANSI/ Ex. Inv -	5.8 -	3.1 -	0,0 -	- -	- -	0.2	ANSI/Ex. Inv	3.4	-	-	- -	- -	Existing Settings
50T/51T T2 51NT-T2	CNP 138 kV T1 Neutral	Siemens Siemens	7SJ602 7SJ602	PH 300:5 GD 600:5	0.4 -	ANSI/ Ex. Inv -	7 -	2.2 -	0.35 -	3.6 -	0 -	- 0.1	- ANSI/Mod. Inv	- 4	- -	- -	- -	- -	Recommended Settings

5.3 RELAY SETTING RECORD (SIEMENS 7SJ62)

Date 20-Mar-14

RELAY		RELAY DESCRIPTION			CT Ratio	PHASE SETTINGS						GROUND SETTINGS						COMMENTS AND ADDITIONAL SETTINGS		
Device ID	Location Bus Name	Mfg.	Model Number	Long Time			Short Time		Instantaneous		Long Time			Short Time		Instantaneous				
				PU 51		Curve Type	Time Dial	PU 50-1	Delay 50-1	PU 50-2	Delay 50-2	PU 51N	Curve Type	Time Dial	PU 50N-1	Delay 50N-1	PU 50N-2		Delay 50N-2	
50/51-T8A	12.47kV BUS-A	Siemens	7SJ62	PH 800:5 GD 800:5	6	ANSI/ Ex. Inv	8	20	0.2	40	0	0.5	ANSI/Ex. Inv.	5.20	0.25	0.25	-	-	Existing Settings	
50/51-T8A	12.47kV BUS-A	Siemens	7SJ62	PH 800:5 GD 800:5	6	ANSI/ V. Inv	6	25	0.15	40	0	-	-	-	0.25	0.25	-	-	Recommended Settings	
50/51-T8B	12.47kV BUS-A	Siemens	7SJ62	PH 800:5 GD 800:5	6	ANSI/ Ex. Inv	8	20	0.2	40	0	0.5	ANSI/Ex. Inv.	5.20	0.25	0.25	-	-	Existing Settings	
50/51-T8B	12.47kV BUS-A	Siemens	7SJ62	PH 800:5 GD 800:5	6	ANSI/ V. Inv	6	25	0.15	40	0	-	-	-	0.25	0.25	-	-	Recommended Settings	
50/51-T6A	12.47kV BUS A	Siemens	7SJ62	PH 200:5 GD 200:5	5	ANSI/ V. Inv	5	25	0.5	100	0.1	0.25	ANSI V. Inv	-	0.75	0.15	-	-	Existing Settings	
50/51-T6A	12.47kV BUS A	Siemens	7SJ62	PH 200:5 GD 200:5	6	ANSI/ V. Inv	5	20	0.2	40	0	-	-	-	0.75	0.15	-	-	Recommended Settings	
50/51-T6B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	5	ANSI/ V. Inv	5	25	0.5	100	0.1	0.25	ANSI Ex./ Inv.	-	0.75	0.15	-	-	Existing Settings	
50/51-T6B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	6	ANSI/ V. Inv	5	20	0.2	40	0	-	-	-	0.75	0.15	-	-	Recommended Settings	
50/51-T2A	12.47kV BUS A	Siemens	7SJ62	PH 300:5 GD 300:5	3.92	ANSI/ Ex. Inv	5	45	0	45	0	5	ANSI/ V. Inv	1.0	-	-	-	-	Existing Settings	
50/51-T2A	12.47kV BUS A	Siemens	7SJ62	PH 300:5 GD 300:5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	See Note Below
50/51-T2B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	9	ANSI/ V. Inv	5	25	0.5	40	0	1	ANSI/ V. Inv	-	0.75	0.15	-	-	Existing Settings	
50/51-T2B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	6	ANSI/ V. Inv	5	20	0.2	40	0	-	-	-	0.75	0.15	-	-	Recommended Settings	
50/51-T7A	12.47kV BUS A	Siemens	7SJ62	PH 200:5 GD 200:5	9	ANSI/ V. Inv	5	25	0.3	45	0	1	ANSI/ V. Inv	00	0.75	0.15	0.25	00	Existing Settings	
50/51-T7A	12.47kV BUS A	Siemens	7SJ62	PH 200:5 GD 200:5	6	ANSI/ V. Inv	5	20	0.2	40	0	-	-	-	0.75	0.15	-	-	Recommended Settings	
50/51-T7B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	9	ANSI/ V. Inv	5	25	0.3	45	0	1	ANSI/ V. Inv	00	0.75	0.15	-	-	Existing Settings	
50/51-T7B	12.47kV BUS B	Siemens	7SJ62	PH 200:5 GD 200:5	6	ANSI/ V. Inv	5	20	0.2	40	0	-	-	-	0.75	0.15	-	-	Recommended Settings	

Note: We understand that several emergency diesel generators are connected to the plant via feeder T2A. At this time we do not have any information on diesel generators and associated protective equipment. It is our understand that Feeder T2A becomes main source of power upon loss of power from Center Point. Without intimate knowledge of all equipment connected to feeder T2A we can not drive settings for Siemens relay associated wth feeder T2A.

5.6 MM2 MOTOR PROTECTION RELAY SETTINGS

5.6 MM2 MOTOR PROTECTION RELAY SETTINGS												
Prot Dev	Func Name	Manufacturer	Relay Type	Phase Settings				Ground Settings				20-Mar-14
				Phase CT Ratio	FLA	O/L Pickup (PU of FLA)	O/L Curve	Ground CT Ratio	GFPU (% of CT Pri)	GFD Running (Sec.)	GFD Starting (Sec.)	Comments
MM2-02-P-03	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-02-P-03	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.10	0.30	Recommended Settings
MM2-02-P-04	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-02-P-04	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.10	0.30	Recommended Settings
MM2-02-P-05	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-02-P-05	Motor Prot	Multilin	MM2	600/5	367	1.16	4	600/5	3.00	0.10	0.30	Recommended Settings
MM2-05-P-03	Motor Prot	Multilin	MM2	800/5	467	1.16	3	800/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-05-P-03	Motor Prot	Multilin	MM2	800/5	467	1.16	3	800/5	3.00	0.10	0.30	Recommended Settings
MM2-04-ME-01	Motor Prot	Multilin	MM2	400/5	142	1.16	4	400/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-04-ME-01	Motor Prot	Multilin	MM2	400/5	142	1.16	4	400/5	3.00	0.10	0.30	Recommended Settings
MM2-04-ME-02	Motor Prot	Multilin	MM2	400/5	142	1.16	4	400/5	3.00	0.00	0.00	Existing Settings From 2003 Study
MM2-04-ME-02	Motor Prot	Multilin	MM2	400/5	142	1.16	4	400/5	3.00	0.10	0.30	Recommended Settings

5.7 RELAY SETTING RECORD (SIEMENS 7UT612)

Column1	Column2	Column4	Column5	Column6
Differential Setting for 87TA & 87TB Transformer Differential - Siemens 7UT612 Relay				
Addr.	Setting Title	Default Setting	Recommended Settings	Comments
1201	Diff. Prot.	Off	On	Differential Protection
1205	Inc.Char.Start	Off	Off	Increase of Trip Char. During Start
1206	Inrush 2.Harm.	On	On	Inrush with 2nd Harmonic Restraint
1207	Restr.n.Harm	Off	5. Harmonic	n-th Harmonic Restraint
1208	I-Diff>Mon.	On	Off	Differential Current Monitoring
1210	I>Curr.Guard	0.00 I/InO	0.00 I/InO	I>for Current Guard
1211A	Diffw.IE1-Meas	No	No	Diff-Prot. With meas. Earth Current S1
1212A	Diffw.IE2-Meas	No	No	Diff-Prot. With meas. Earth Current S2
1221	I-Diff>	0.20 I/InO	0.20 I/InO	Pickup Value of Differential Curr.
1226A	T I-Diff>	0.00 Sec	0.00 Sec	T I-Diff> Time Delay
1231	I-Diff>>	7.5 I/InO	8.3 I/InO	Pickup Value of High Set Trip
1236A	T I-Diff>>	0.00 Sec	0.00 Sec	T I-Diff>> Time Delay
1241A	Slope 1	0.25	0.25	Slope 1 of Tripping Characteristic
1242A	Base Point 1	0.00 I/InO	0.00 I/InO	Base Point for Slope 1 of Charac.
1243A	Slope 2	0.5	0.5	Slope 2 of Tripping Characteristic
1244A	Base Point 2	2.5 I/InO	2.5 I/InO	Base Point for Slope 2 of Charac.
1251A	I-Rest.Startup	0.10 I/InO	-	I-Restraint for Start Detection (not used)
1252A	Start-Factor	1	-	Factor for Increasing of Char. at Start (not used)
1253	T Start Max	5.0 Sec	-	Maximum Permissible Start Time (not used)
1256A	I-Add On Stab.	4.00 I/InO	4.00 I/InO	Pickup for Add-on Stabilization
1257A	T Add On-Stab.	15 Cycles	15 Cycles	Duration of Add-on Stabilization
1261	2. Harmonic	15%	15%	2nd Harmonic Content in I-Diff
1262A	Crossb.2.Harm	3 Cycles	0 Cycle	Time for Cross-blocking 2nd Harmonic
1271	n. Harmonic	30%	30%	n-th Harmonic Content in I-Diff
1272A	Crossb.n.Harm	0 Cycle	0 Cycle	Time for Cross-blocking n-th Harmonic
1273A	IDiffmax n.HM	1.5 I/InO	1.5 I/InO	Limit IDiffmax of n-th Harm.
1281	I-Diff> Mon.	0.20 I/InO	0.20 I/InO	Pickup value of diff. Current Monitoring
1282	T I-Diff> Mon.	2 Sec	2 Sec	T I-Diff> Monitoring Time Delay

Additional Notes to Field Technician

1. When setting the system electrical parameters in relay please refer to substation drawings by Dashiell Corp.
2. If the technician finds that Dashiell Drawings do not reflect the present electrical system, please inform COH or their engineer of discrepancies.
3. When setting the Transformer Vector Group please take into account phase rotation and CT connection configuration.
4. Also note that primary CT ratio tap is 300/5 and not 150/5 as shown on Dashiell drawing 18618-1101.

5.8 SWITCHBOARD 5 BREAKER SETTINGS

5.8 SWITCHBOARD 5 BREAKER SETTINGS																		
DESIGNATION	CIRCUIT BREAKER			TRIP DEVICE						TRIP DEVICE SETTING								COMMENTS
NAME	MFG.	TYPE	FRAME AMPS	TYPE	SENSOR RATING	PLUG RATING (In)	LT RANGE	ST RANGE	GF RANGE	LONG TIME		SHORT TIME		INST.	GRD. FAULT		I ² t	
										P.U. (Ir)	DELAY (SEC)	P.U.	DELAY (SEC)	P.U.	P.U.	DELAY (SEC)	IN/OUT	
SWBD5A-m	C-H	SPB-100	3000	RMS 510 LSI	3000	2000	0.5 - 1.0 X P	2 - 8 X LT	100-1200A	1 X P	24	4 X LT	0.1	M2(10)	A	0.2	See Comment	I ² t Phase In, Ground Out Inst phase 20KA fixed
SWBD5-TIE	C-H	CRD	2000	RMS 310 LS	2000	2000	fixed 1 X P	fixed	2 - 8 X P	fixed	fixed	3 X LT	fixed	fixed	-	-	See Comment	I ² t Phase In. Inst phase 17.5KA fixed
SWBD5B-m	C-H	SPB-100	3000	RMS 510 LSI	3000	2000	0.5 - 1.0 X P	2 - 8 X LT	100-1200A	1 X P	24	4 X LT	0.1	M2(10)	A	0.2	See Comment	I ² t Phase In, Ground Out Inst phase 20KA fixed
SWBD5A-f-02P01	C-H	HMDL	800	RMS 310 LSI		800	fixed	2 - 8 X LT	-	fixed 1 X P	fixed	2 X LT	0.1	fixed	-	-	See Comment	With VFD. I ² t Phase Out Inst phase 5.5KA fixed
SWBD5B-f-02P02	C-H	HMDL	800	RMS 310 LSI		800	fixed	2 - 8 X LT	-	fixed 1 X P	fixed	2 X LT	0.1	fixed	-	-	See Comment	With VFD. I ² t Phase Out Inst phase 5.5KA fixed
SWBD5A-f-02P03	C-H	HMDL	800	RMS 310 LSI		800	fixed	2 - 8 X LT	-	fixed 1 X P	fixed	4 X LT	0.1	fixed	-	-	See Comment	With RVSS. I ² t Phase Out Inst phase 5.5KA fixed
SWBD5B-f-02P04	C-H	HMDL	800	RMS 310 LSI		800	fixed	2 - 8 X LT	-	fixed 1 X P	fixed	4 X LT	0.1	fixed	-	-	See Comment	With RVSS. I ² t Phase Out Inst phase 5.5KA fixed
SWBD5A-f-02P05	C-H	HMDL	800	RMS 310 LSI		800	fixed	2 - 8 X LT	-	fixed 1 X P	fixed	4 X LT	0.1	fixed	-	-	See Comment	With RVSS. I ² t Phase Out Inst phase 5.5KA fixed

5.9 SWITCHBOARD 6 BREAKER SETTINGS

DESIGNATION	CIRCUIT BREAKER			TRIP DEVICE						TRIP DEVICE SETTING							COMMENTS		
	NAME	MFG.	TYPE	FRAME AMPS	TYPE	SENSOR RATING	PLUG RATING (In)	LT RANGE	ST RANGE	GF RANGE	LONG TIME		SHORT TIME		INST.	GRD. FAULT		I ² t IN/OUT	
											P.U. (Ir)	DELAY (SEC)	P.U.	DELAY (SEC)		P.U.			DELAY (SEC)
SWBD6A-f-MCC1A	C-H	HMDL	800	RMS 310 LSIG		800	Fixed	2-8 X LT	1-5 X Ig	fixed	fixed	8 X LT	Inst	fixed	1 X Ig	0.15	See Comment	I ² t Phase In, Ground Out Inst phase 5.5KA fixed	
SWBD6A-f-04ME01	C-H	HJD	250	THERMAL MAGNETIC	-	225	-	-	-	-	-	-	-	10	-	-	-	Instantaneous Range = 5-10 x Trip Set at 10 (2250A)	
SWBD6A-f-05P01	C-H	HMDL	800	THERMAL MAGNETIC		700	-	-	-	-	-	-	-	4	-	-	-	Instantaneous Range = 4-8 x Trip Set at 4 (2800A)	
SWBD6A-f-05P03	C-H	HMDL	800	THERMAL MAGNETIC		700	-	-	-	-	-	-	-	8	-	-	-	Instantaneous Range = 4-8 x Trip Set at 8 (5600A)	
SWBD6A-f-MCC2C	C-H	HKD	400	THERMAL MAGNETIC		400	-	-	-	-	-	-	-	5	-	-	-	Instantaneous Range = 5-10 x Trip Set at 5 (2000A)	
SWBD6A-f-SWBD STDBY	C-H	HMDL	800	THERMAL MAGNETIC		600	-	-	-	-	-	-	-	10	-	-	-	Instantaneous Range = 5-10 x Trip Set at 10 (6000A)	
SWBD6A-f-MCC2A	C-H	HMDL	800	THERMAL MAGNETIC		600	-	-	-	-	-	-	-	10	-	-	-	Instantaneous Range = 5-10 x Trip Set at 10 (6000A)	
SWBD6A-f-SWBDIIA	C-H	HMDL	800	RMS 310 LSIG		600	Fixed	2 - 8 X LT	1 - 5 X Ig	fixed 1 X P	fixed	4 X LT	.1	fixed	1 X Ig	0.15	See Comment	I ² t Phase In, Ground Out Inst phase 5.5KA fixed	
SWBD6A-m	C-H	SPB-100	3000	RMS 510 LSG	3000		0.5 - 1.0 X Sensor (S) fixed	2 - 8 X LT	100-1200A	1 X S	10	3 X LT	0.1	fixed	A 750A	0.3	See Comment	I ² t Phase In, Ground Out Inst phase 35KA fixed	
SWBD6-TIE	C-H	CRD	2000	RMS 310 LS	2000		1 X Sensor (S) fixed	2 - 8 X LT	-	fixed	fixed	3 X LT	fixed	fixed	-	-	See Comment	I ² t Phase In Inst phase 17.5KA fixed	
SWBD6B-m	C-H	SPB-100	3000	RMS 510 LSG	3000		0.5 - 1.0 X Sensor (S) fixed	2 - 8 X LT	100-1200A	1 X S	10	3 X LT	0.1	fixed	A 750A	0.3	See Comment	I ² t Phase In, Ground Out Inst phase 35KA fixed	
SWBD6B-f-MCC1B	C-H	HMDL	800	RMS 310 LSIG		800	Fixed	2-8 X LT	1-5 X Ig	fixed	fixed	8 X LT	Inst	fixed	1 X Ig	0.15	See Comment	I ² t Phase In, Ground Out Inst phase 5.5KA fixed	
SWBD6B-f-04ME02	C-H	HJD	250	THERMAL MAGNETIC	-	225	-	-	-	-	-	-	-	10	-	-	-	Instantaneous Range = 5-10 x Trip Set at 10 (2250A)	
SWBD6B-f-MCC2D	C-H	HKD	400	THERMAL MAGNETIC		400	-	-	-	-	-	-	-	5	-	-	-	Instantaneous Range = 5-10 x Trip Set at 5 (2000A)	
SWBD6B-f-05P02	C-H	HMDL	800	THERMAL MAGNETIC		700	-	-	-	-	-	-	-	4	-	-	-	Instantaneous Range = 4-8 x Trip Set at 4 (2800A)	
SWBD6B-f-MCC2B	C-H	HMDL	800	THERMAL MAGNETIC		600	-	-	-	-	-	-	-	10	-	-	-	Instantaneous Range = 5-10 x Trip Set at 10 (6000A)	
SWBD6B-f-SWBDIIB	C-H	HMDL	800	RMS 310 LSIG		600	Fixed	2 - 8 X LT	1 - 5 X Ig	fixed 1 X P	fixed	4 X LT	0.1	fixed	1 X Ig	0.15	See Comment	I ² t Phase In, Ground Out Inst phase 5.5KA fixed	

Section 6

Appendix

- Center Point Energy Memo Dated 9-16-2011
- Phase 1 Record Drawings
- Phase 2 Record Drawings
- HSPS1 (High Service Pump Station 1) One Line Diagram

Memorandum

Date: 9/16/2011
To: Wayne Watts
From: William Allen
Subject: System Impedance at 138kV DEUSEN Substation
 12121 NORTH SAM HOUSTON PKWY EAST
 HOUSTON, TEXAS

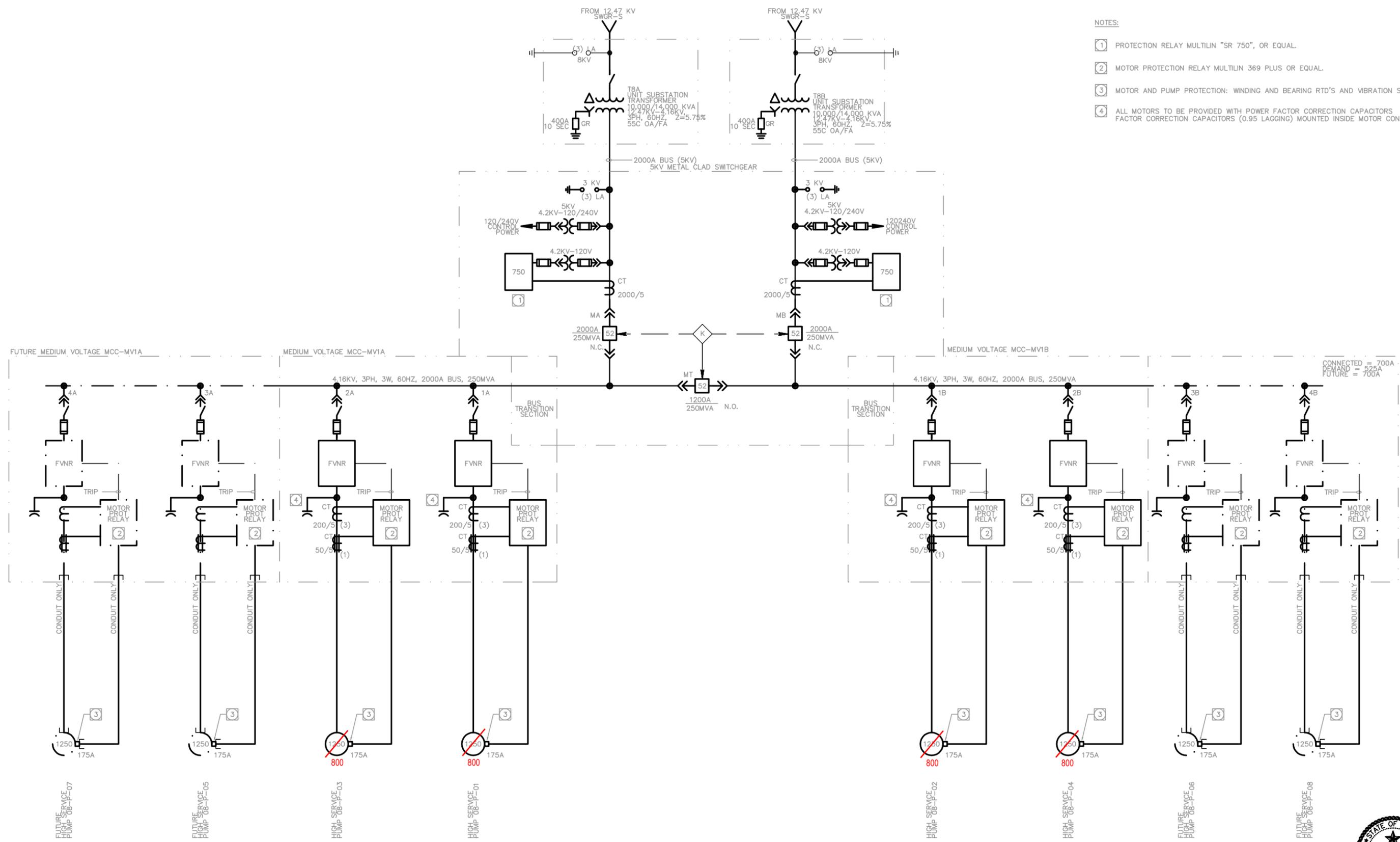
The following information was provided in per unit on a 100MVA base @ 138kV:

System Configuration/ Scenario	Three Phase (I _A) [MVA]	Single Phase (3I ₀) [MVA]	Thevenin's Equivalent Voltage Source [p.u.]	Thevenin's Equivalent System Impedance [p.u.]					
				Positive		Negative		Zero	
				Z	X/R	Z	X/R	Z	X/R
Both 138kV Lines In-Service	3992	2516	1.0285	0.02650	9.79	0.02648	9.73	0.07238	5.45
Ckt #94 to HUMBLE Out-of-Service	1707	1001	1.0343	0.06268	9.73	0.06263	9.71	0.19388	5.17
Ckt #94 to CHAMON Out-of-Service	2496	1723	1.0258	0.04217	9.41	0.04216	9.38	0.09758	6.19

CenterPoint Energy will require any 138kV substation design to conform to their specification for customer owned 138kV substations.

NOTES:

- ① PROTECTION RELAY MULTILIN "SR 750", OR EQUAL.
- ② MOTOR PROTECTION RELAY MULTILIN 369 PLUS OR EQUAL.
- ③ MOTOR AND PUMP PROTECTION: WINDING AND BEARING RTD'S AND VIBRATION SWITCHES.
- ④ ALL MOTORS TO BE PROVIDED WITH POWER FACTOR CORRECTION CAPACITORS (0.95 LAGGING) MOUNTED INSIDE MOTOR CONTROL CENTER.



MEDIUM VOLTAGE (5KV) MOTOR CONTROL CENTER MCC-MV-1
(LOCATED IN THE HIGH SERVICE PUMP STATION)

**PHASE 1
RECORD DRAWING**

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147 on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
2	2-13-2008	EMP	RECORD DRAWING
1	7-29-2007	REA	ISSUED FOR CONSTRUCTION
0	2-15-2007	REA	COH Building Permit Department

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE THEN IT IS NOT TO SCALE

DESIGNED	G. DE BOIS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY	(RECOMMENDED)	LICENSE NO.	DATE
		LICENSE NO.	DATE



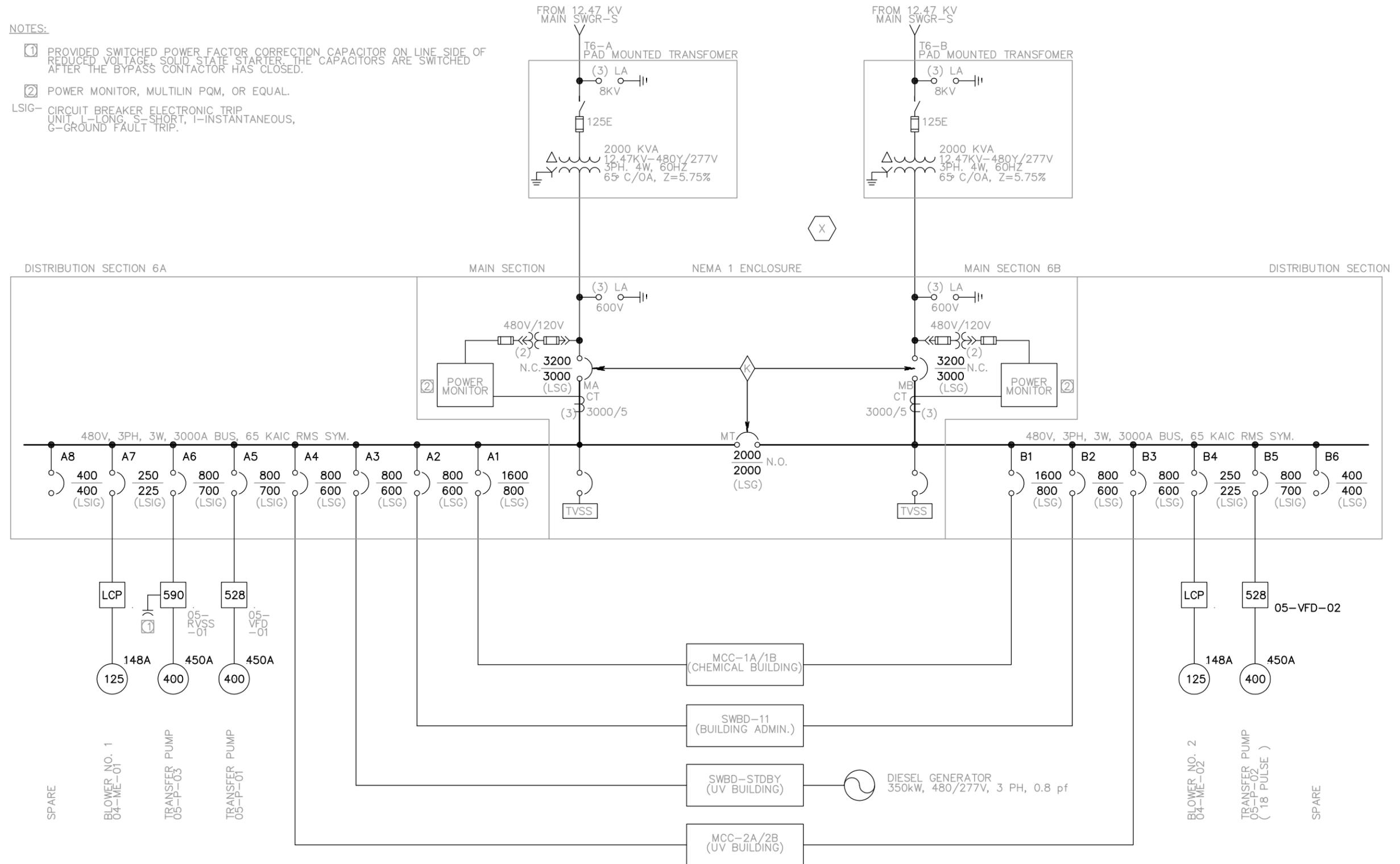
Houston Area Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
HIGH SERVICE PUMP STATION
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-MV-1

SHEET
GE-9

NOTES:

- ① PROVIDED SWITCHED POWER FACTOR CORRECTION CAPACITOR ON LINE SIDE OF REDUCED VOLTAGE. SOLID STATE STARTER. THE CAPACITORS ARE SWITCHED AFTER THE BYPASS CONTACTOR HAS CLOSED.
 - ② POWER MONITOR, MULTILIN PQM, OR EQUAL.
- LSIG- CIRCUIT BREAKER ELECTRONIC TRIP UNIT, L-LONG, S-SHORT, I-INSTANTANEOUS, G-GROUND FAULT TRIP.



480V SWITCHBOARD SWBD-6
(LOCATED IN UV ELECTRICAL RM)

**PHASE 1
RECORD DRAWING**

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147, on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
2	7-13-2003	SMP	RECORD DRAWING
1	7-29-2003	REA	ISSUED FOR CONSTRUCTION
0	5-6-2003	REA	COH BUILDING PERMIT DEPARTMENT

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE THEN DRAWING IS NOT TO SCALE

DESIGNED	L. PHELPS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

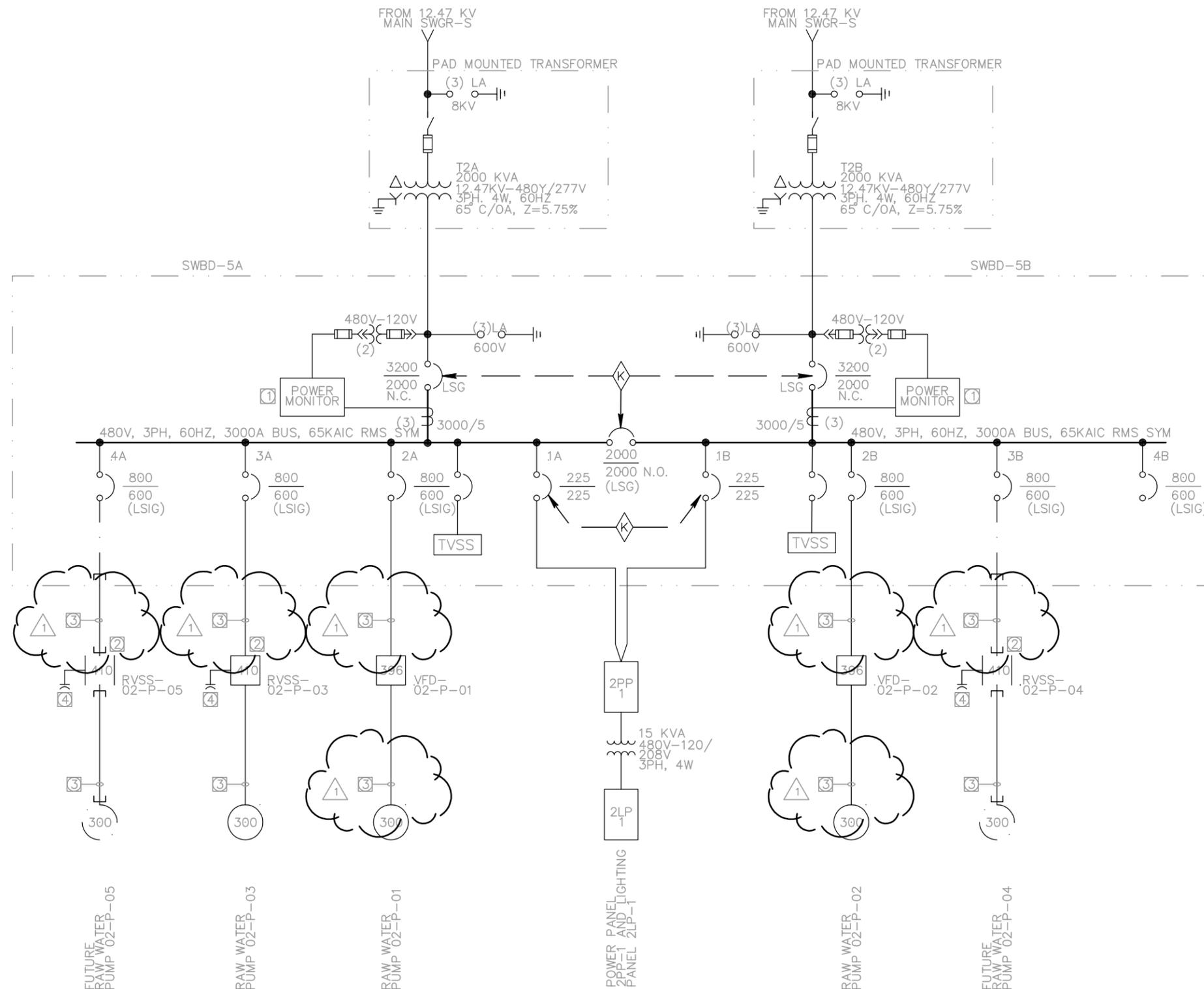
SUBMITTED BY	(RECOMMENDED)	LICENSE NO.	DATE
		LICENSE NO.	DATE



Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
SINGLE LINE DIAGRAM
UV BUILDING
SWITCHBOARD SWBD-6

SHEET
GE-10



- NOTES:
- ① POWER MONITOR: MULTILIN PQM, OR APPROVED EQUAL
 - ② CONTROLLER WITH MULTILIN MMII MOTOR PROTECTION MODULE, OR APPROVED EQUAL
 - ③ WIRES SHALL BE SIZED FOR FUTURE 500 HP MOTOR
 - ④ ALL MOTORS TO BE PROVIDED WITH POWER FACTOR CORRECTION CAPACITORS EXCEPT THOSE WITH VFDs. CAPACITORS SHALL BE SWITCHED SO THEY OPERATE AFTER BYPASS CONTACTOR HAS CLOSED.
- LSIG- CIRCUIT BREAKER ELECTRONIC TRIP UNIT, L-LONG, S-SHORT, I-INSTANTANEOUS, G-GROUND FAULT TRIP.

480V SWITCHBOARD SWBD-5
(LOCATED IN RAW WATER PS ELECTRICAL RM)

**PHASE 1
RECORD DRAWING**

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147, on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
2	2-13-2001	SMP	RECORD DRAWING
1	3-29-2001	REA	Cable Size Change Clarification
0	3-22-2001	REA	COH BUILDING PERMIT DEPARTMENT

SCALE
NONE

WARNING
IF THIS BAR DOES NOT MEASURE THEN DRAWING IS NOT TO SCALE

DESIGNED L. PHELPS
DRAWN L. PHELPS
CHECKED R. ABORDO

SUBMITTED BY
(RECOMMENDED)
LICENSE NO. DATE
LICENSE NO. DATE

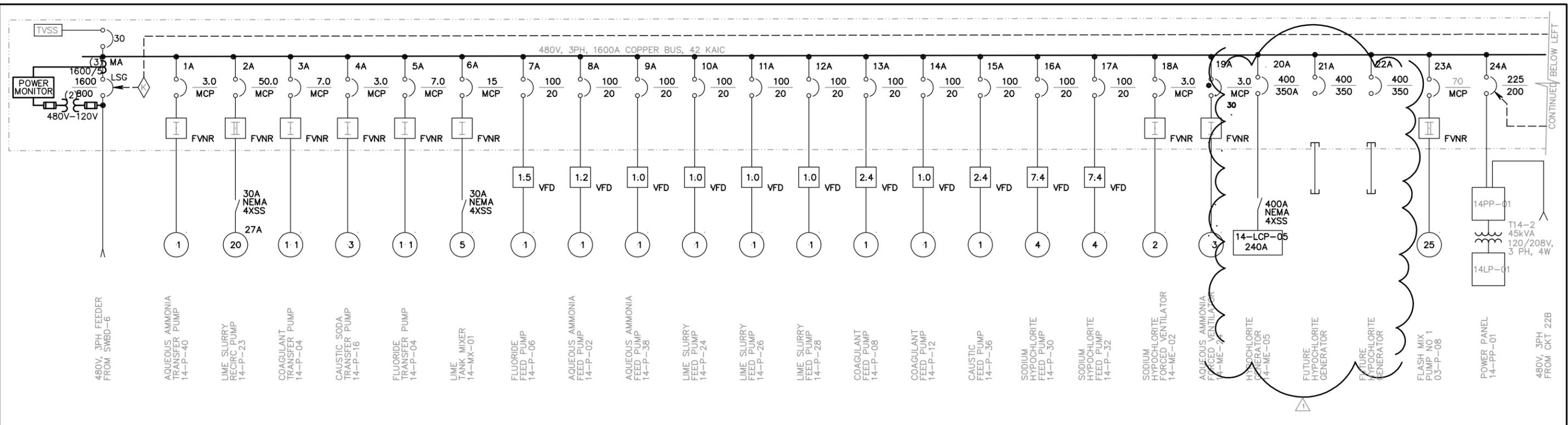
5100 Westheimer, Suite 580
Houston, TX 77056

MWH
MONTGOMERY WATSON HARZA

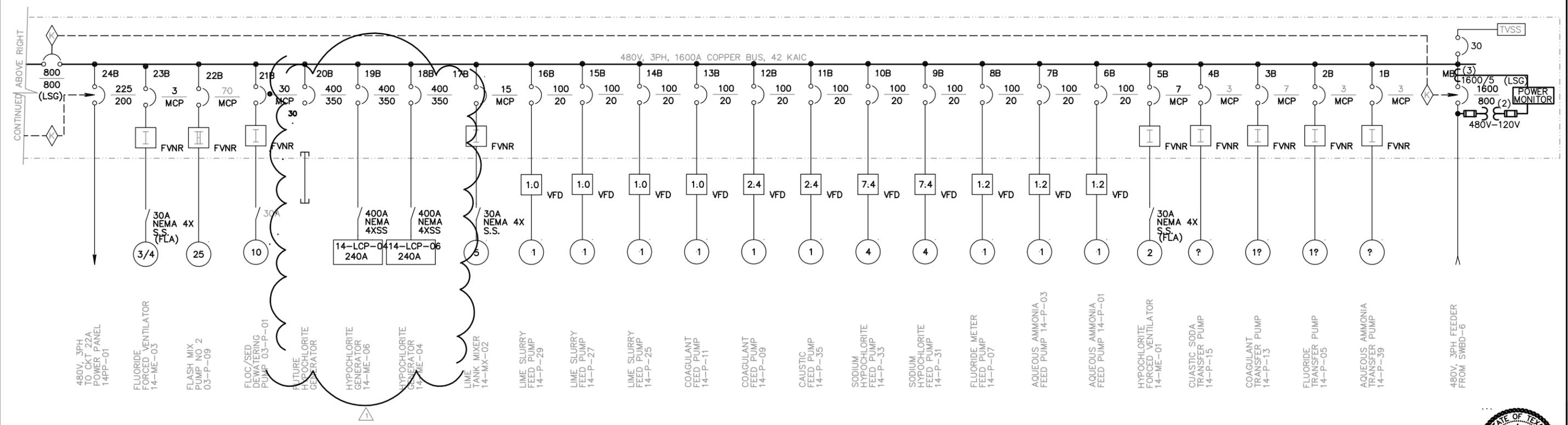
Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
RAW WATER PUMP STATION
SINGLE LINE DIAGRAM
RAW WATER PUMP STATION SWBD-5

SHEET
GE-11



MOTOR CONTROL CENTER MCC-1A
(LOCATED IN CHEMICAL BUILDING ELECTRICAL ROOM)



MOTOR CONTROL CENTER MCC-1B
(LOCATED IN CHEMICAL BUILDING ELECTRICAL ROOM)

**PHASE 1
RECORD DRAWING**

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147, on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
3	2-13-2008	SMP	RECORD DRAWING
2	7-29-2007	REA	ISSUED FOR CONSTRUCTION
1	6-14-2007	REA	Design Changes
0	3-6-2007	REA	COH Building Permit Department

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	L. PHELPS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY	(RECOMMENDED)
LICENSE NO.	DATE
LICENSE NO.	DATE

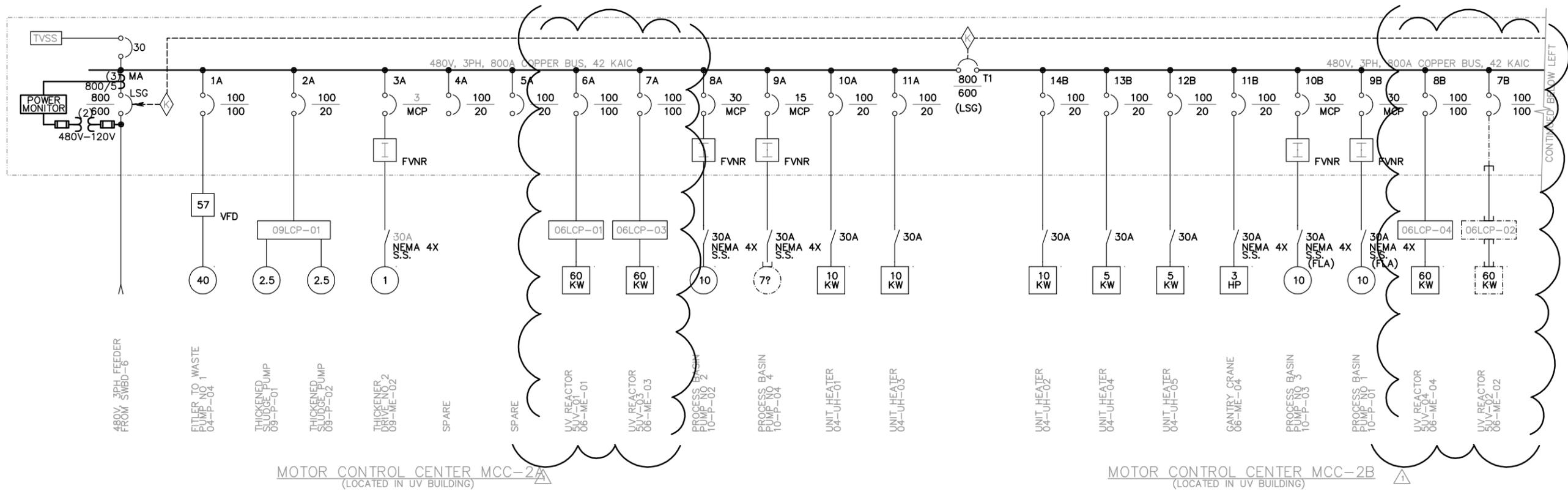
5100 Westheimer, Suite 580
Houston, TX 77056

MWH
MONTGOMERY WATSON HARZA

Houston Area
Water Corporation

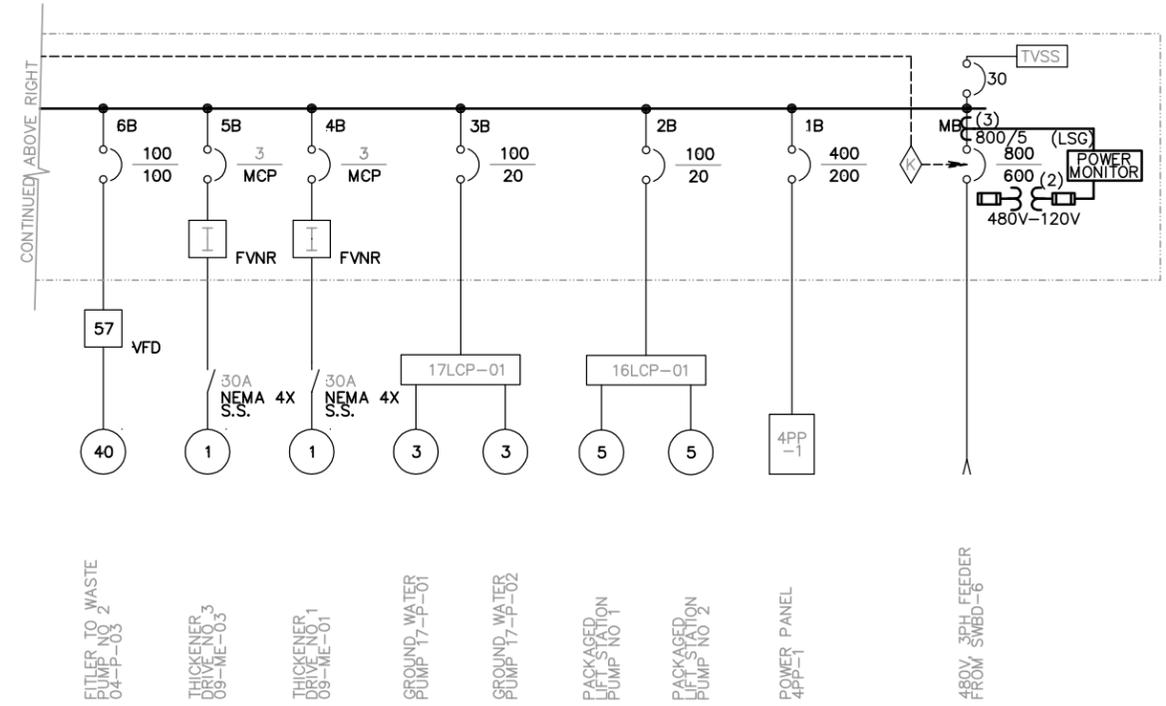
NORTHEAST WATER PURIFICATION SYSTEM
CHEMICAL BUILDING
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-1A/1B

SHEET
GE-12



MOTOR CONTROL CENTER MCC-2A
(LOCATED IN UV BUILDING)

MOTOR CONTROL CENTER MCC-2B
(LOCATED IN UV BUILDING)



MOTOR CONTROL CENTER MCC-2B (CONT.)
(LOCATED IN UV BUILDING)

PHASE 1 RECORD DRAWING

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147, on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
2	2-13-20	ASMP	RECORD DRAWING
1	6-10-20	2REA	Design Changes
0	3-6-2002	REA	COH Building Permit Department

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE 1 IS NOT TO SCALE

DESIGNED	L. PHELPS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY	(RECOMMENDED)	LICENSE NO.	DATE
		LICENSE NO.	DATE



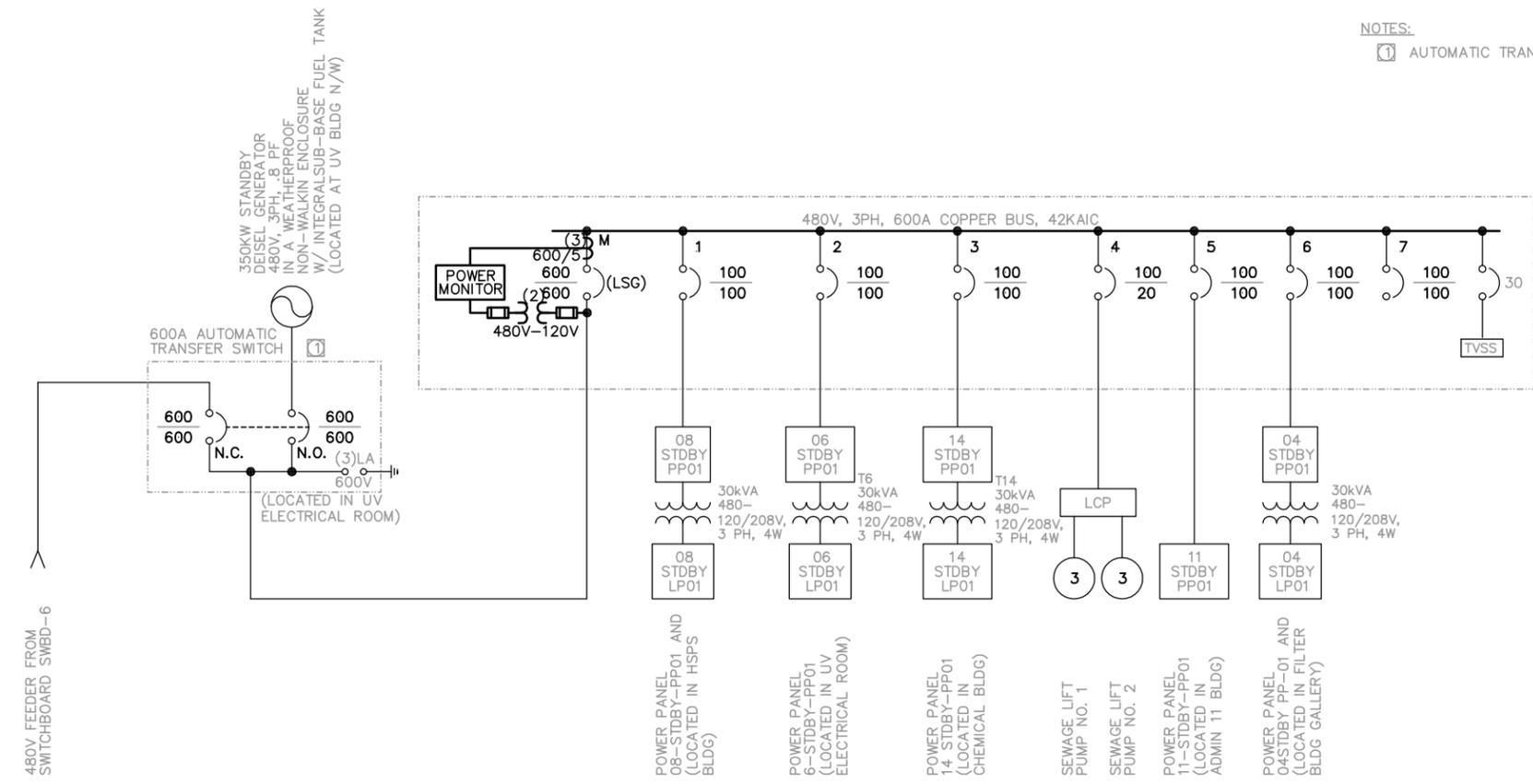
Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
UV BUILDING
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-2A/2B

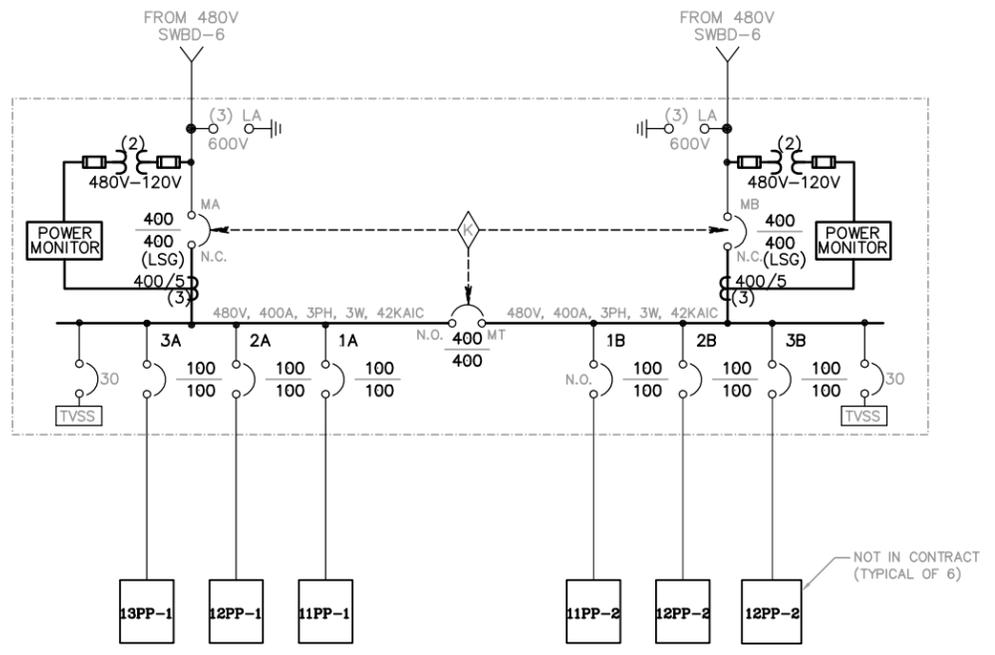
SHEET
GE-13

NOTES:

① AUTOMATIC TRANSFER SWITCH SHALL BE CUTLER HAMMER ATVMAA30600XSU, OR APPROVED EQUAL.



STANDBY SWITCHBOARD SWBD-STDBY
(LOCATED IN UV ELECTRICAL ROOM)



SWITCHBOARD SWBD-11
(LOCATED IN ADMINISTRATION BUILDING)

**PHASE 1
RECORD DRAWING**

The Seal appearing on this document was authorized by Robert E. Abordo, P.E. 84147, on Date Indicated for Revision 1



REV	DATE	BY	DESCRIPTION
2	2-13-2014	SM	RECORD DRAWING
1	7-29-2013	REA	ISSUED FOR CONSTRUCTION
0	1-14-2014	REA	COH Building Permit Department

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

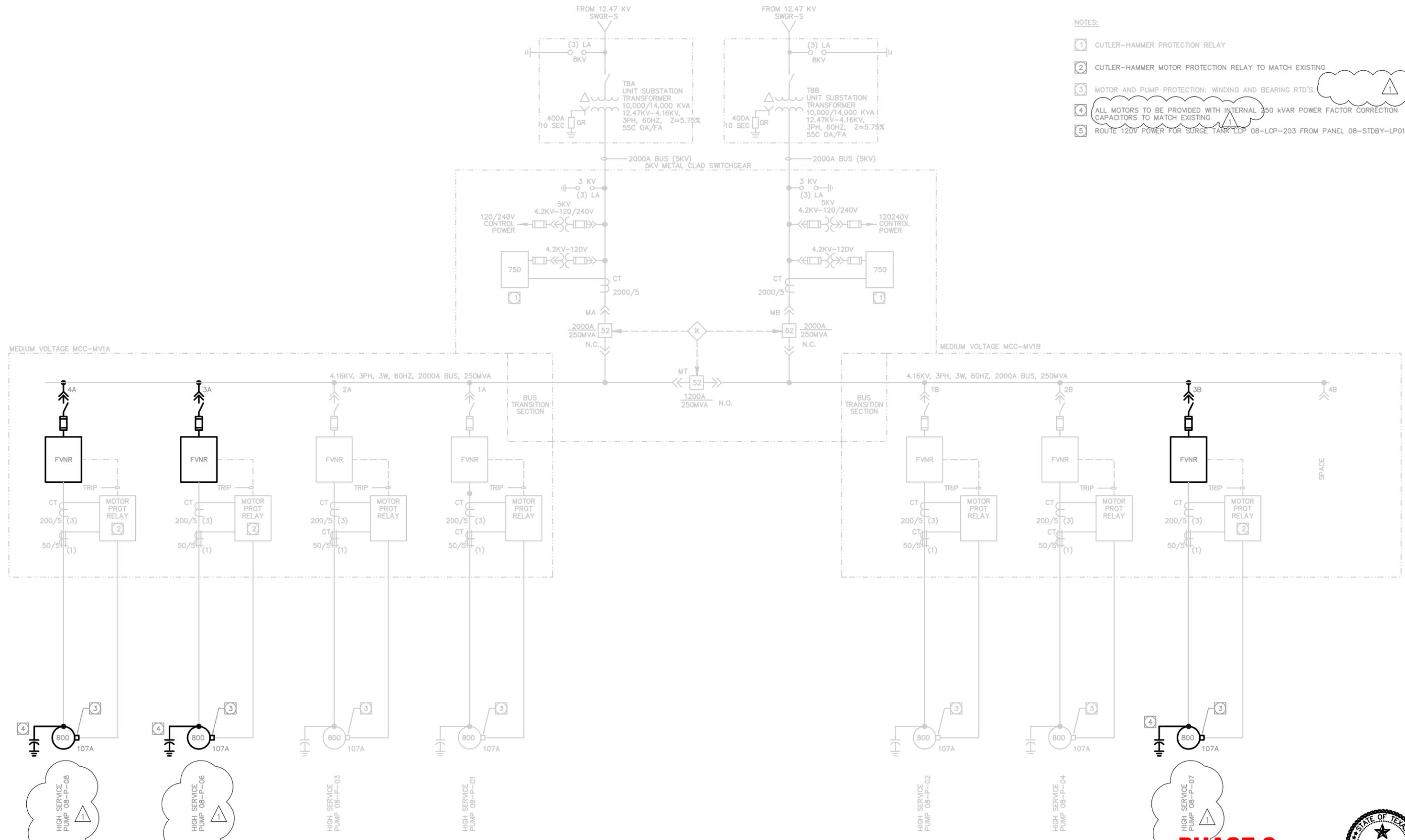
DESIGNED	G. DE BOIS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY	(RECOMMENDED)	LICENSE NO.	DATE
		LICENSE NO.	DATE



Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
SINGLE LINE DIAGRAM
ADMINISTRATION BUILDING
STANDBY SWITCHBOARD SWBD-STBY



- NOTES:
- 1 CUTLER-HAMMER PROTECTION RELAY
 - 2 CUTLER-HAMMER MOTOR PROTECTION RELAY TO MATCH EXISTING
 - 3 MOTOR AND PUMP PROTECTION: WINDING AND BEARING RTD'S.
 - 4 ALL MOTORS TO BE PROVIDED WITH INTERNAL 250 KVAR POWER FACTOR CORRECTION CAPACITORS TO MATCH EXISTING
 - 5 ROUTE 120V POWER FOR SURGE TANK LCP 08-LCP-203 FROM PANEL 08-STDBY-LP01.

MEDIUM VOLTAGE (5KV) MOTOR CONTROL CENTER MCC-MV-1
(LOCATED ADJACENT TO THE HIGH SERVICE PUMP STATION)

**PHASE 2
RECORD DRAWING**



REV	DATE	BY	DESCRIPTION
1	01-27-08	EPBM	Record Drawing

SCALE: NONE
 WARNING: IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED: R. ABORDO
 DRAWN: L. PHELPS
 CHECKED: R. ABORDO

SUBMITTED BY: _____
 (RECOMMENDED) _____
 LICENSE NO. _____ DATE _____
 LICENSE NO. _____ DATE _____



5100 Westheimer, Suite 580
Houston, TX 77056

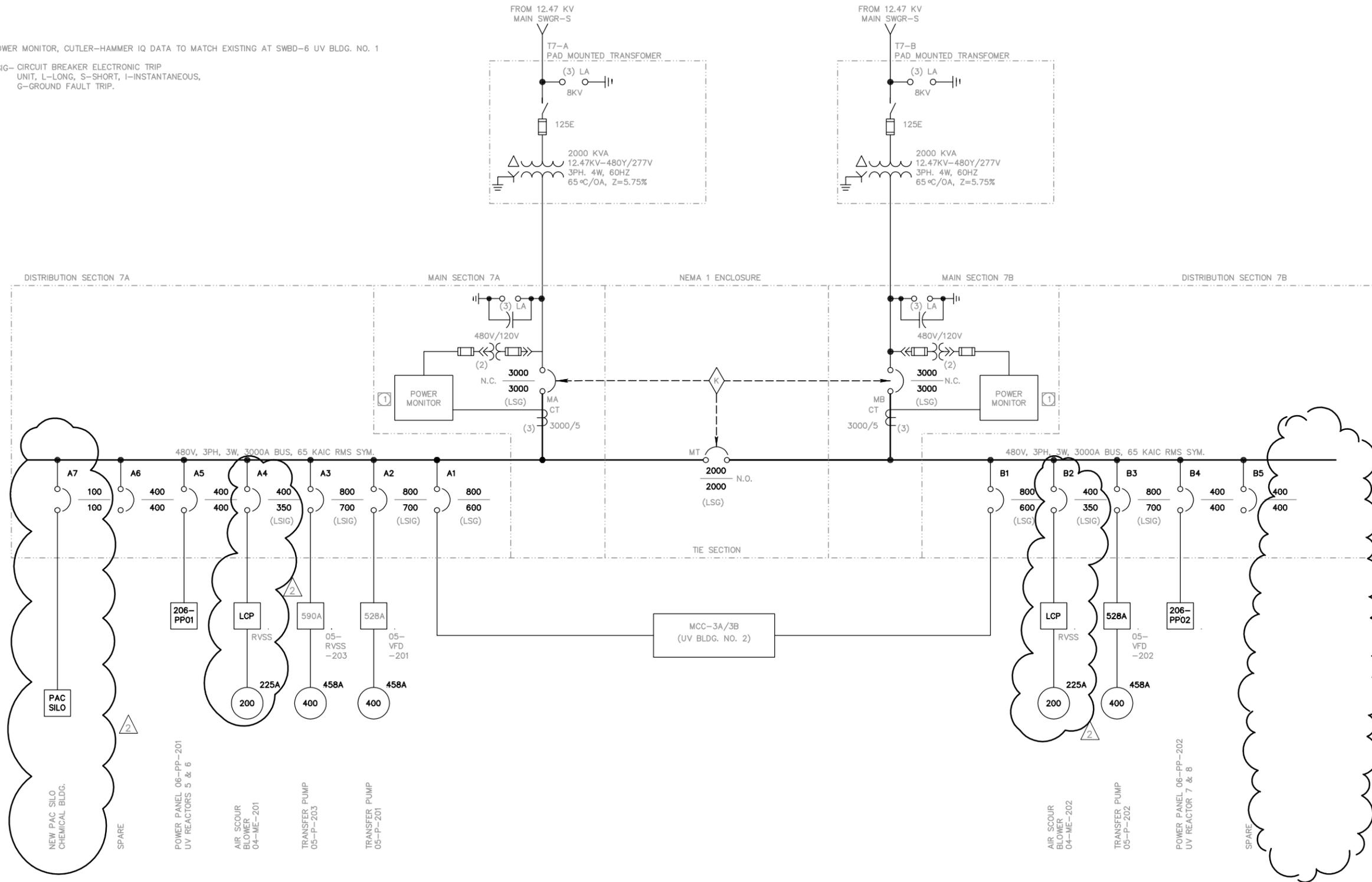
Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
PHASE 2 EXPANSION
HIGH SERVICE PUMP STATION
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-MV-1

SHEET
GE-9

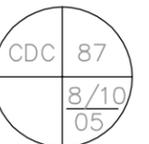
NOTES:

- ① POWER MONITOR, CUTLER-HAMMER IQ DATA TO MATCH EXISTING AT SWBD-6 UV BLDG. NO. 1
- LSIG- CIRCUIT BREAKER ELECTRONIC TRIP UNIT, L-LONG, S-SHORT, I-INSTANTANEOUS, G-GROUND FAULT TRIP.



480V SWITCHBOARD SWBD-7
(LOCATED IN UV BLDG. NO. 2 ELECTRICAL RM)

**PHASE 2
RECORD DRAWING**



REV	DATE	BY	DESCRIPTION
2	01-27-08	CPBM	Record Drawing
1	5-27-05	LRP	PAC SILO Modification
0	10-18-04	RMC	HAWC and Permit Agency Approval

SCALE

WARNING

0 ? 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	L. PHELPS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY		
(RECOMMENDED)	LICENSE NO.	DATE
	LICENSE NO.	DATE

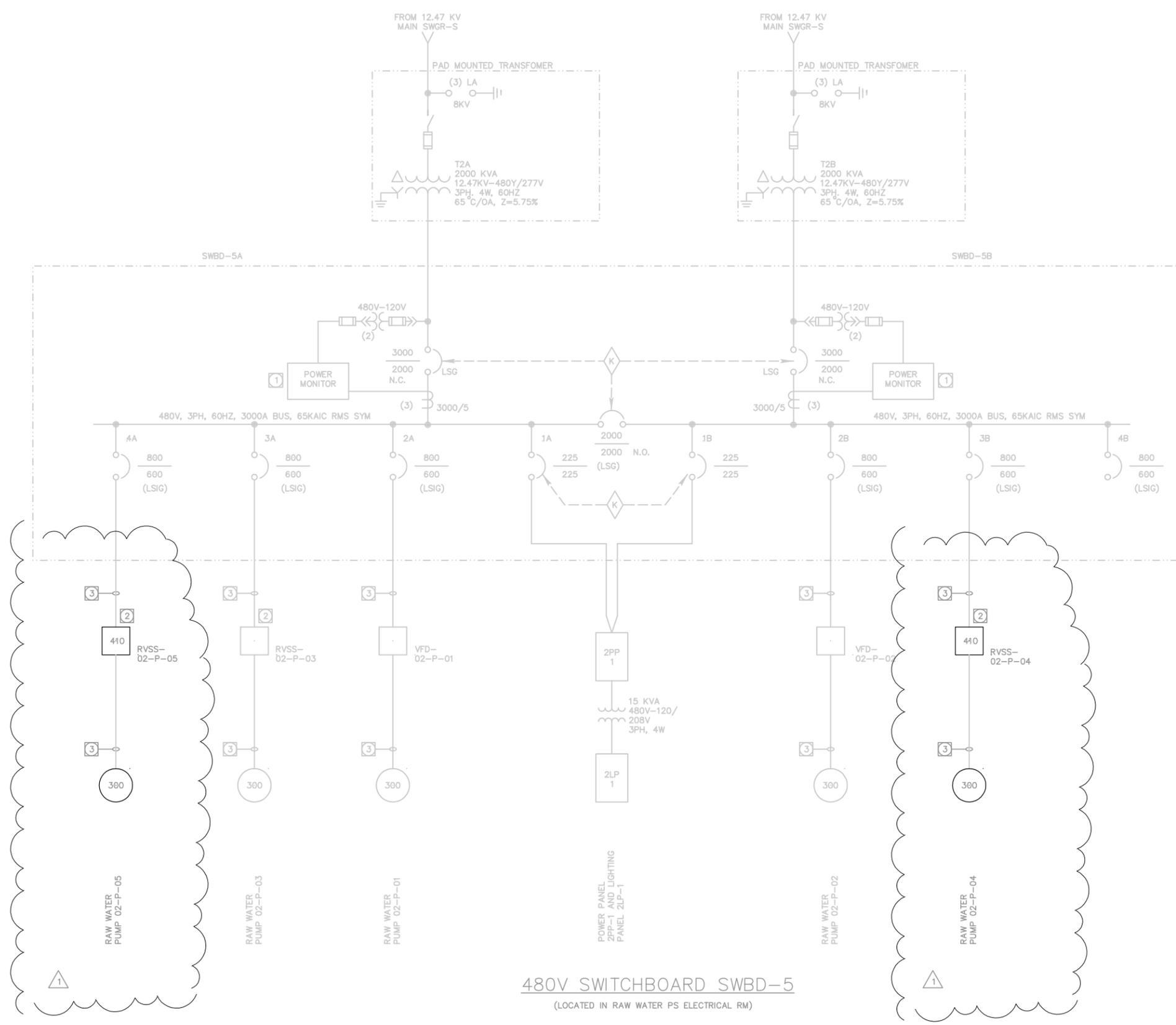


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Houston, TX 77056

Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
PHASE 2 EXPANSION
SINGLE LINE DIAGRAM
UV BUILDING NO. 2
SWITCHBOARD SWBD-7

SHEET
GE-10



- NOTES:
- ① POWER MONITOR: CH IQ DATA
 - ② CONTROLLER WITH CUTLER-HAMMER MOTOR PROTECTION MODULE TO MATCH EXISTING.
 - ③ WIRES SHALL BE SIZED FOR FUTURE 500 HP MOTOR
- LSIG- CIRCUIT BREAKER ELECTRONIC TRIP UNIT, L-LONG, S-SHORT, I-INSTANTANEOUS, G-GROUND FAULT TRIP.

LOAD CALCULATION SWBD-5 (480V):
NOTE: 1 HP APPROX. EQUALS 1 KVA

(4) 300 HP MOTORS @ 300 kVA EACH	1,200,000 VA
(1) STANDBY	
25% OF LARGEST MOTOR	75,000 VA
LIGHTING	15,000 VA
FUTURE	300,000 VA
TOTAL:	1,590,000 VA

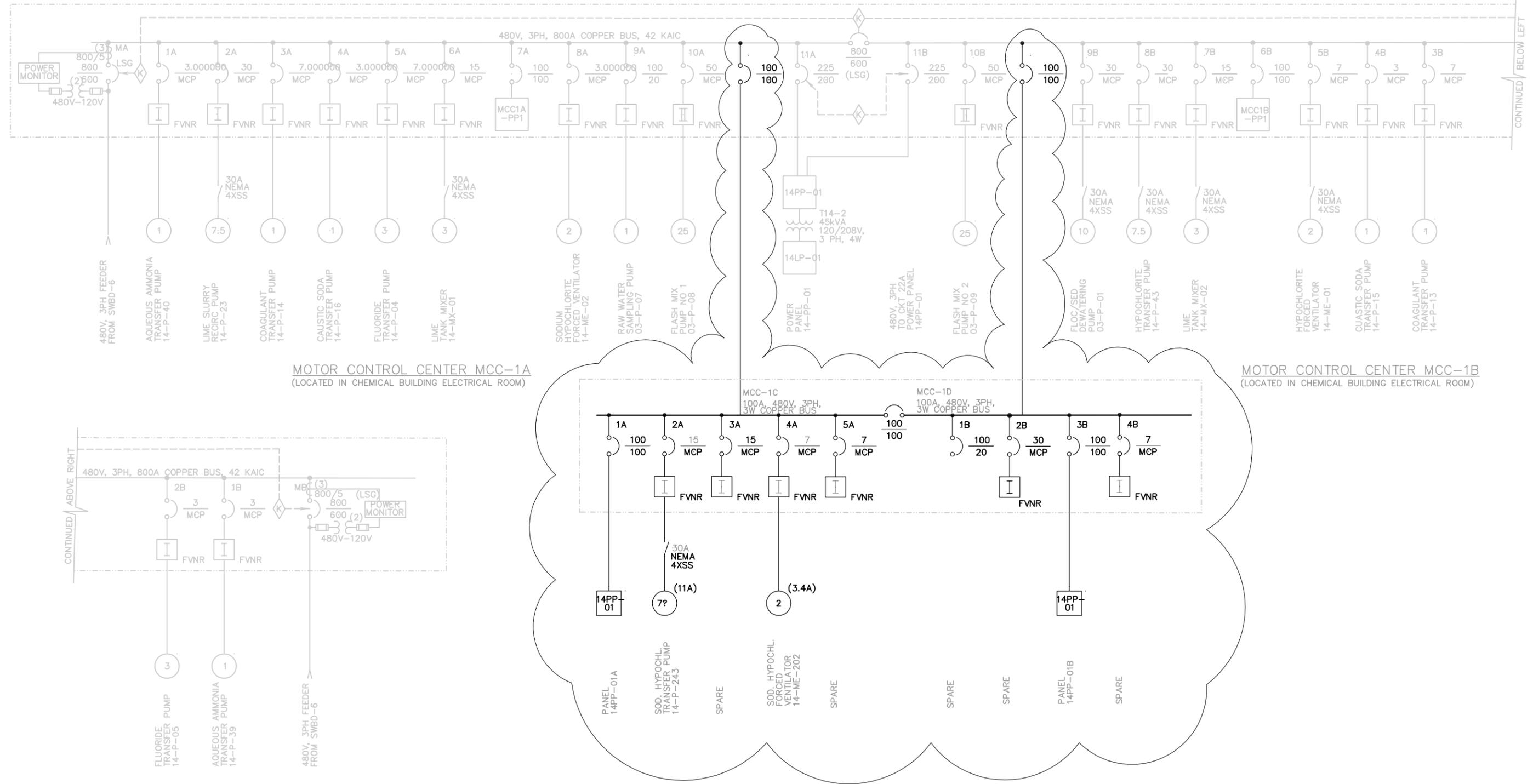
SINGLE TRANSFORMER IN SERVICE @ 2,000,000 VA
SERVICE AMPACITY (2,000 KVA x 1.25%) 3000 A
SWBD FEEDER SIZE (8) 500 KCMIL, 75 DEG, XHHW

480V SWITCHBOARD SWBD-5
(LOCATED IN RAW WATER PS ELECTRICAL RM)

**PHASE 2
RECORD DRAWING**



<table border="1"> <tr> <td>2</td> <td>01-31-08PBM</td> <td>Record Drawing</td> </tr> <tr> <td>1</td> <td>12-10-04LRP</td> <td>COH Building Permit Department</td> </tr> <tr> <td>REV</td> <td>DATE</td> <td>BY</td> </tr> <tr> <td></td> <td></td> <td>DESCRIPTION</td> </tr> </table>			2	01-31-08PBM	Record Drawing	1	12-10-04LRP	COH Building Permit Department	REV	DATE	BY			DESCRIPTION	<p>SCALE</p> <p>WARNING</p> <p>0 ? 1</p> <p>IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE</p>	<p>DESIGNED L. PHELPS</p> <p>DRAWN L. PHELPS</p> <p>CHECKED R. ABORDO</p>	<p>SUBMITTED BY</p> <p>(RECOMMENDED)</p> <p>LICENSE NO.</p> <p>DATE</p>	<p>5100 Westheimer, Suite 580 Houston, TX 77056</p> <p>MWH MONTGOMERY WATSON HARZA</p>	<p>Houston Area Water Corporation</p>	<p>NORTHEAST WATER PURIFICATION SYSTEM PHASE 2 EXPANSION</p> <p>RAW WATER PUMP STATION SINGLE LINE DIAGRAM RAW WATER PUMP STATION SWBD-5</p>	<p>SHEET</p> <p>GE-11</p>
2	01-31-08PBM	Record Drawing																			
1	12-10-04LRP	COH Building Permit Department																			
REV	DATE	BY																			
		DESCRIPTION																			



MOTOR CONTROL CENTER MCC-1A
(LOCATED IN CHEMICAL BUILDING ELECTRICAL ROOM)

MOTOR CONTROL CENTER MCC-1B
(LOCATED IN CHEMICAL BUILDING ELECTRICAL ROOM)

MOTOR CONTROL CENTER MCC-1B
(LOCATED IN CHEMICAL BUILDING ELECTRICAL ROOM)

**PHASE 2
RECORD DRAWING**



REV	DATE	BY	DESCRIPTION
1	01-27-08	CFBM	Record Drawing
0	10-18-07	RMG	HAWC and Permit Agency Approval

SCALE

WARNING
0 ? 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED L. PHELPS
DRAWN L. PHELPS
CHECKED R. ABORDO

SUBMITTED BY
(RECOMMENDED)

LICENSE NO. DATE
LICENSE NO. DATE



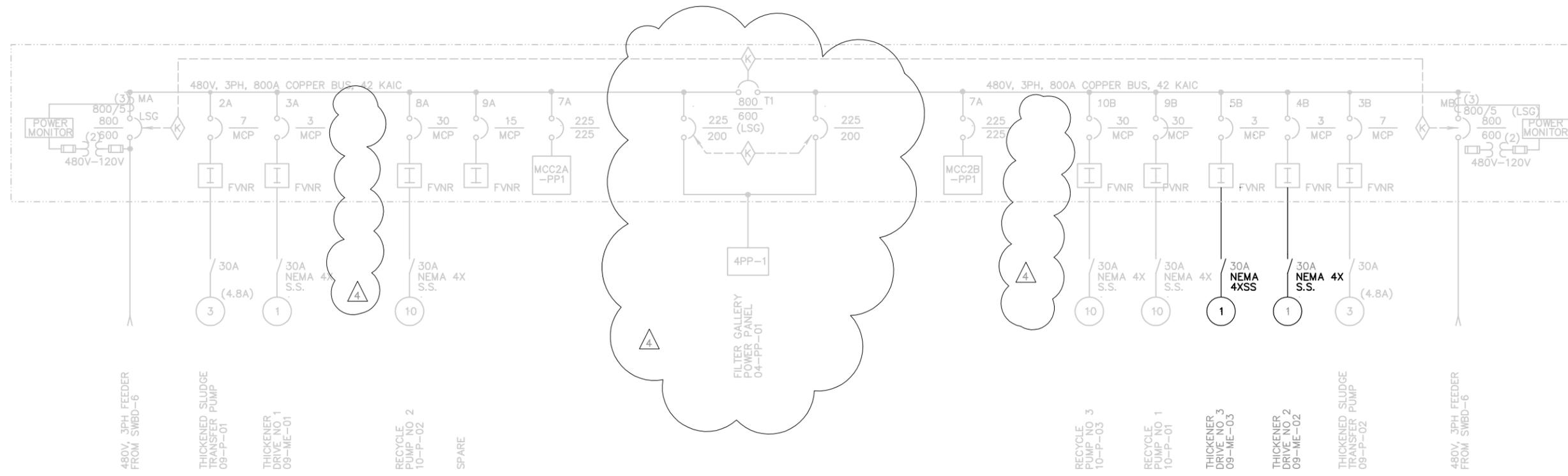
5100 Westheimer, Suite 580
Houston, TX 77056

MWH
MONTGOMERY WATSON HARZA

Houston Area
Water Corporation

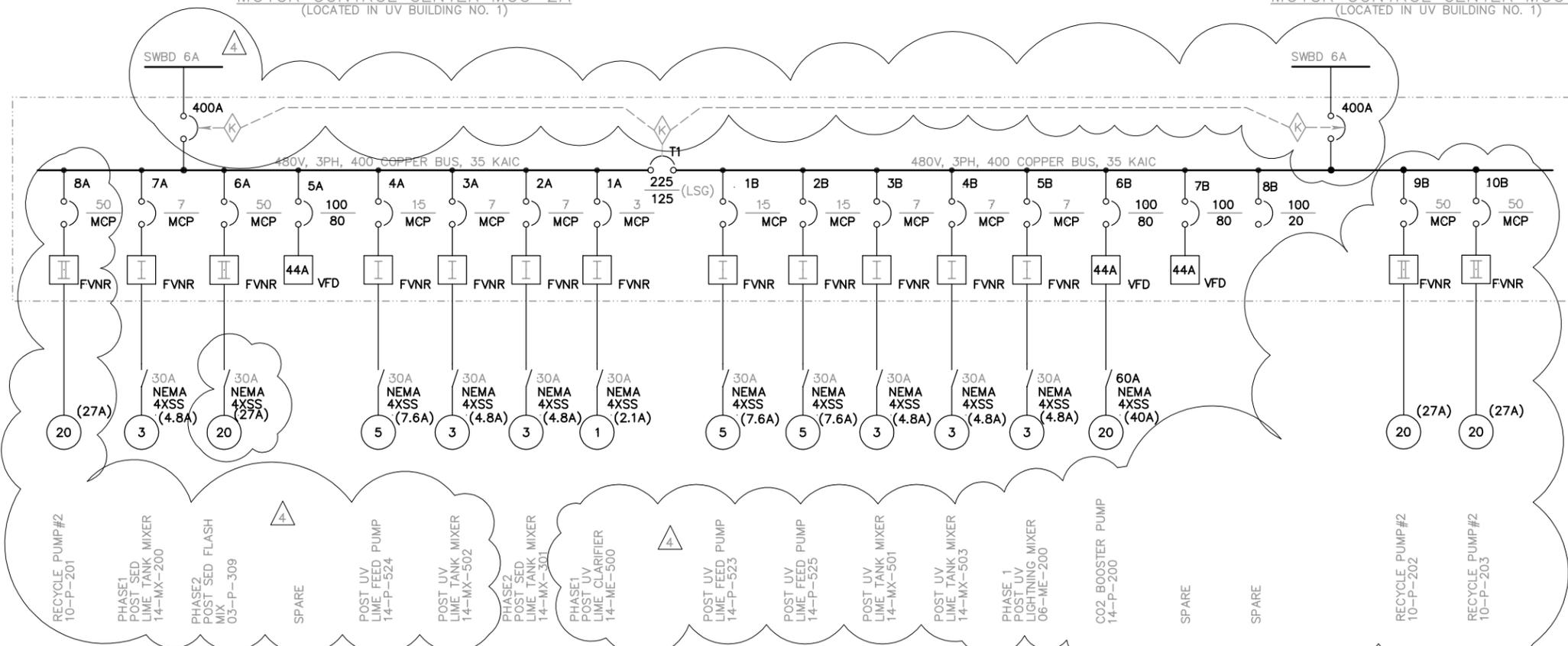
NORTHEAST WATER PURIFICATION SYSTEM
PHASE 2 EXPANSION
CHEMICAL BUILDING
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-1A/1B

SHEET
GE-12



MOTOR CONTROL CENTER MCC-2A
(LOCATED IN UV BUILDING NO. 1)

MOTOR CONTROL CENTER MCC-2B
(LOCATED IN UV BUILDING NO. 1)



MOTOR CONTROL CENTER MCC-2C
(LOCATED IN UV BUILDING NO. 1)

MOTOR CONTROL CENTER MCC-2D
(LOCATED IN UV BUILDING NO. 1)

- NOTES:
1. ADD SECOND SLUDGE THICKENER SUMP PUMP 09-P-205 TO EXISTING PUMP 09-P-05 AND REWIRE LCP FOR DUPLEX OPERATION. FEED NEW LCP FROM PANEL MCC2B-PP01 USING NEW 20A, 3 POLE CIRCUIT 32,34,36.

**PHASE 2
RECORD DRAWING**



REV	DATE	BY	DESCRIPTION
4	01-27-08	EPBM	Record Drawing
3	10-18-04	RFMC	HAWC and Permit Agency Approval
2	3-18-2003		Submittal Response
1	6-10-2002	REA	Design Changes
0	3-6-2002	REA	COH Building Permit Department

SCALE	NONE
WARNING	IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	L. PHELPS
DRAWN	L. PHELPS
CHECKED	R. ABORDO

SUBMITTED BY	(RECOMMENDED)	LICENSE NO.	DATE
		LICENSE NO.	DATE

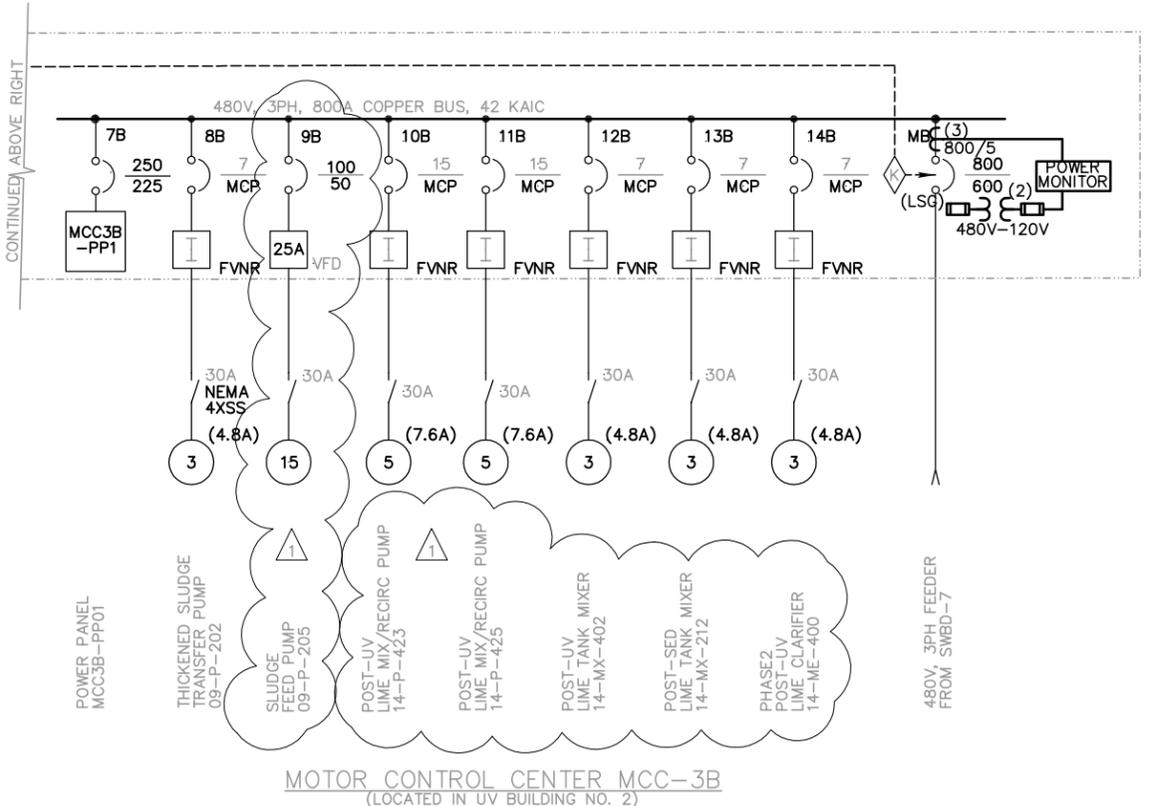
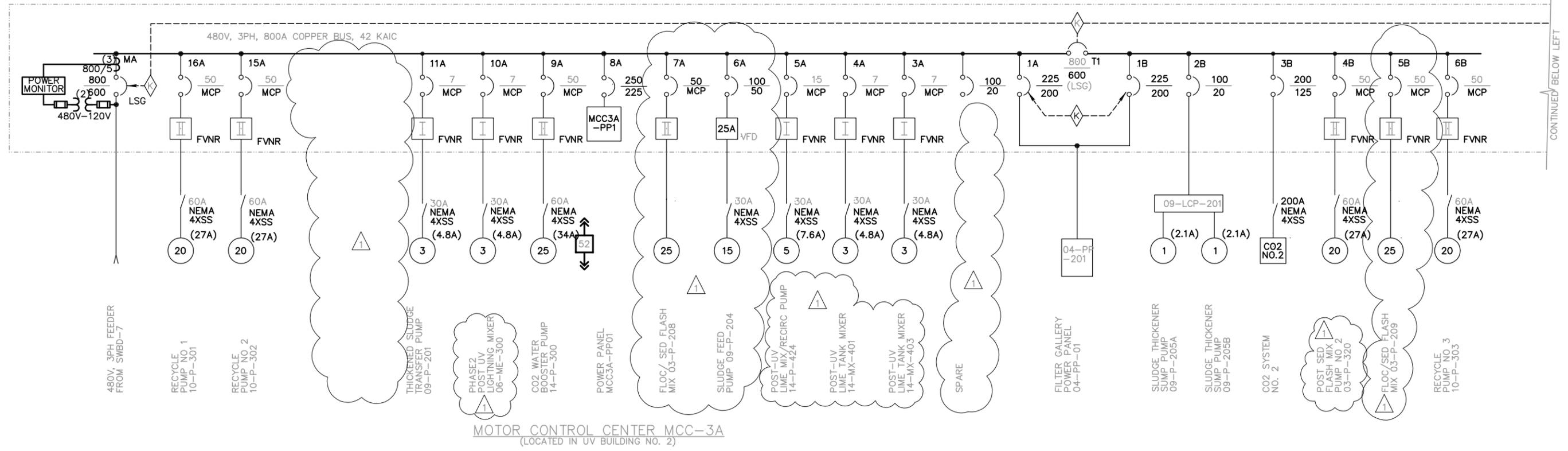


5100 Westheimer, Suite 580
Houston, TX 77056

Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
PHASE 2 EXPANSION
PHASE 1
UV BUILDING
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-2A/2B

SHEET
GE-13



**PHASE 2
RECORD DRAWING**



REV	DATE	BY	DESCRIPTION
1	01-27-08	EPBM	Record Drawing
0	10-18-04	ARMC	HAWC and Permit Agency Approval

SCALE	WARNING
	IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	DRAWN	CHECKED
----------	-------	---------

SUBMITTED BY	LICENSE NO.	DATE
(RECOMMENDED)		
	LICENSE NO.	DATE

5100 Westheimer, Suite 580
Houston, TX 77056

MWH
MONTGOMERY WATSON HARZA

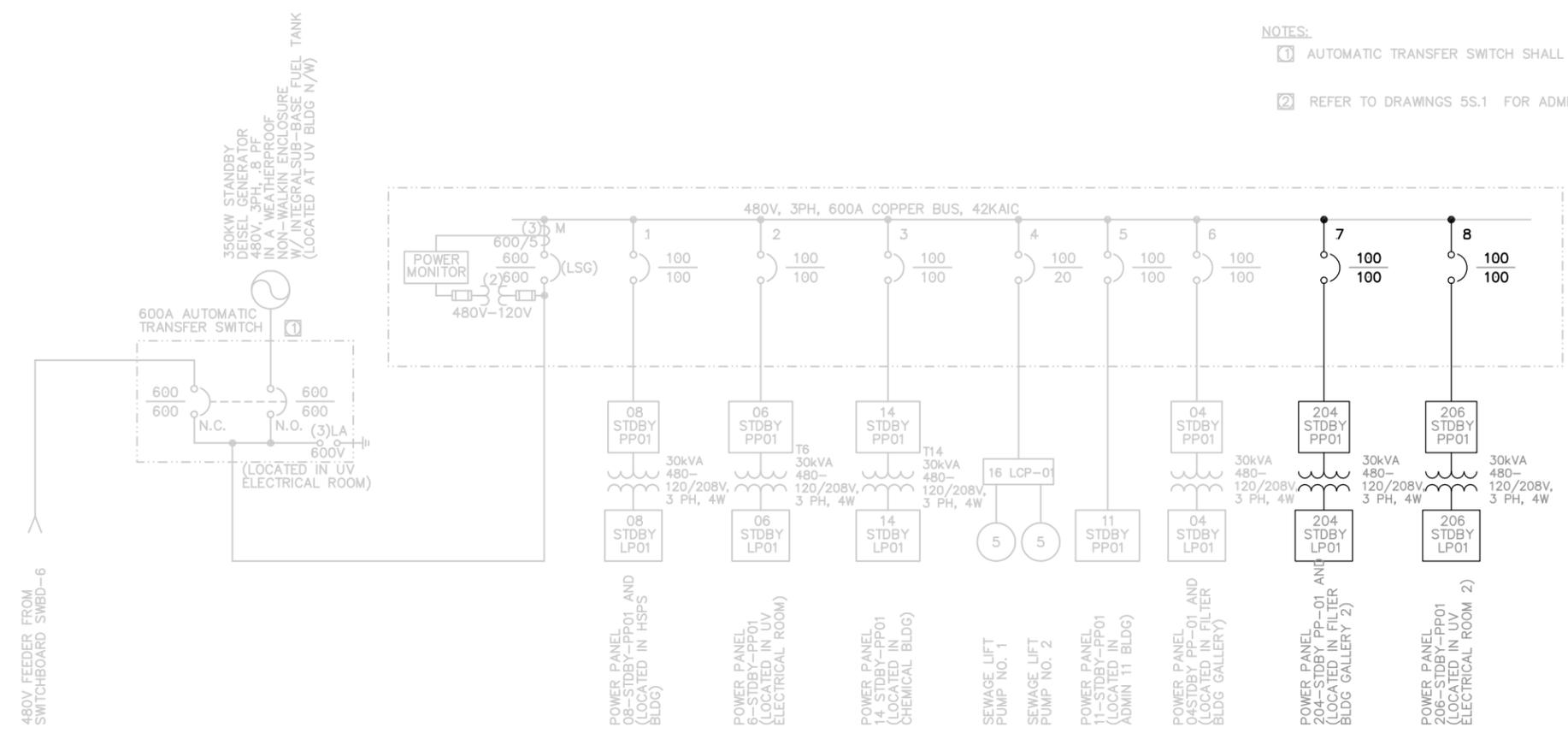
Houston Area
Water Corporation

NORTHEAST WATER PURIFICATION SYSTEM
PHASE 2 EXPANSION

UV BUILDING NO. 2
SINGLE LINE DIAGRAM
MOTOR CONTROL CENTER MCC-3A/3B

SHEET
GE-14

- NOTES:
- ① AUTOMATIC TRANSFER SWITCH SHALL BE CUTLER HAMMER ATMMAA30600XSU, OR APPROVED EQUAL.
 - ② REFER TO DRAWNGS 5S.1 FOR ADMINISTRATION BUILDING ELECTRICAL ONE LINE DIAGRAMS.



STANDBY SWITCHBOARD SWBD-STDBY
(LOCATED IN UV ELECTRICAL ROOM)

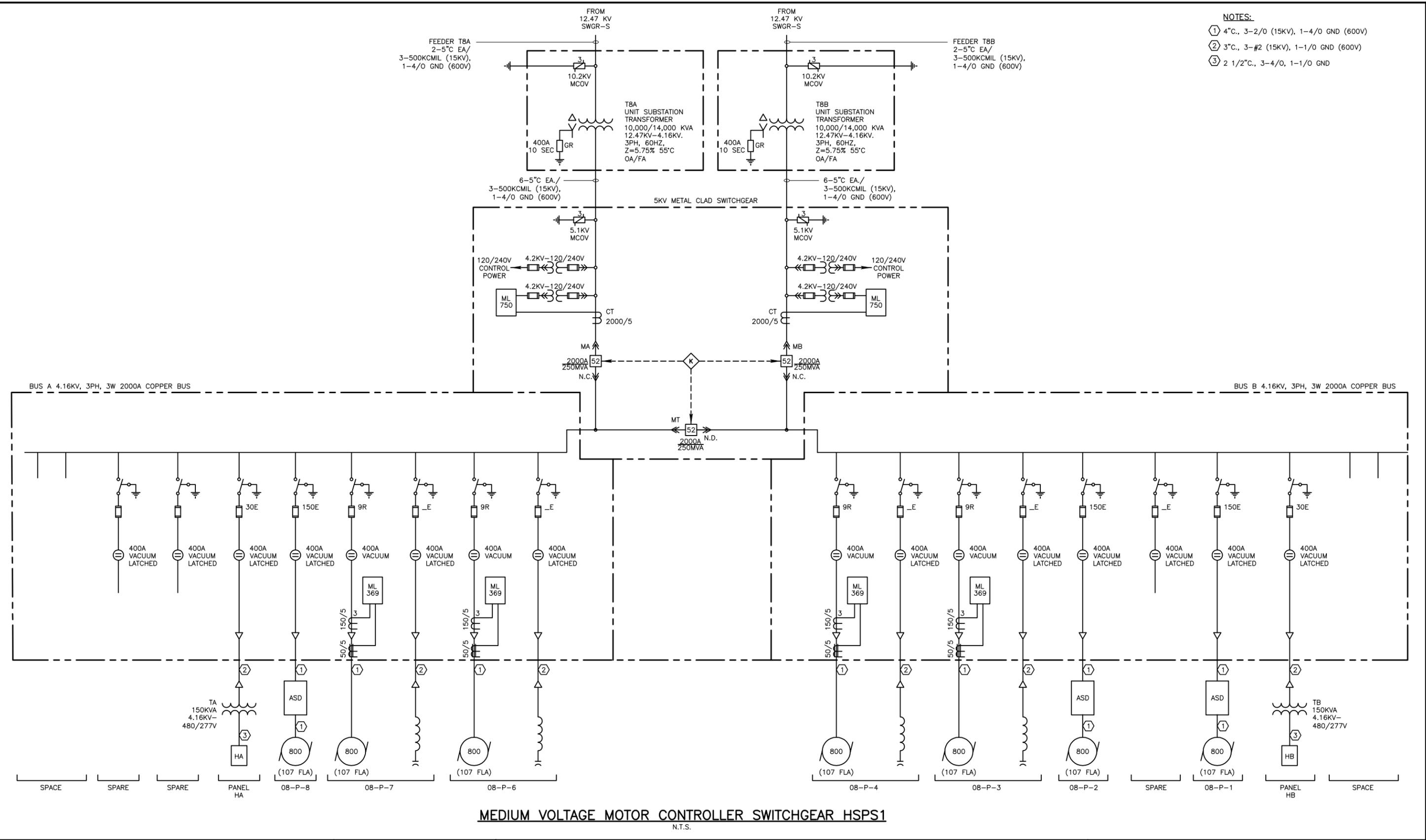
NOTE:

1. 120V POWER FOR UV BUILDING EXHAUST FANS AND LOUVERS SHALL BE SUPPLIED FROM LIGHTING PANEL 206-STDBY-LP01
2. 480V, 3 PHASE POWER FOR FILTER VALVES AND BLOWER VALVE 04-V-243 SHALL BE SUPPLIED FROM POWER PANELS 04-PP-201 AND 204-STDBY-PP01.



**PHASE 2
RECORD DRAWING**

SCALE WARNING IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE			DESIGNED G. DE BOIS DRAWN L. PHELPS CHECKED R. ABORDO			SUBMITTED BY (RECOMMENDED) _____ LICENSE NO. _____ DATE _____ _____ LICENSE NO. _____ DATE _____			5100 Westheimer, Suite 580 Houston, TX 77056 MWH MONTGOMERY WATSON HARZA			Houston Area Water Corporation			NORTHEAST WATER PURIFICATION SYSTEM PHASE 2 EXPANSION ADMINISTRATION BUILDING SINGLE LINE DIAGRAM STANDBY SWITCHBOARD SWBD-STBY			SHEET GE-15		
1	01-27-06	PBM	Record Drawings																	
0	12-17-01	RMC	HAWC and Permit Agency Approval																	
REV	DATE	BY	DESCRIPTION																	



- NOTES:**
- ① 4" C., 3-2/0 (15KV), 1-4/0 GND (600V)
 - ② 3" C., 3-#2 (15KV), 1-1/0 GND (600V)
 - ③ 2 1/2" C., 3-4/0, 1-1/0 GND

MEDIUM VOLTAGE MOTOR CONTROLLER SWITCHGEAR HSPS1
N.T.S.



3050 Post Oak Boulevard, Suite 300
Houston, TX 77056
Tel: (713) 423-7300
TBPE Firm Registration No. F-3043

KGI Kalluri Group, Inc.
Consulting Engineers & Project Managers
TBPE Registration No. F-665
10497 Town & Country Way, Suite 220
Houston, Texas 77024
Phone: (713)-365-9288



CITY OF HOUSTON
WBS NO. S-000066-0012-3
NORTHEAST WATER PURIFICATION PLANT IMPROVEMENTS
CHEMICAL FEED SYSTEM

PROJECT NO. 8138-92757

MEDIUM VOLTAGE MOTOR CONTROL SWITCHGEAR HSPS1

MAR 2014